For engineers who design and manage the power and plant services

# Power

APRIL 1959 • ONE DOLLAR

A McGRAW-HILL PUBLICATION

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# AEG

## Factory-assembled panels for low-voltage switchboards

Designed to save space with a clear layout.
Metal clad for accident prevention.
Cellular-type for reliable functioning.
Truck-mounted breakers for safe and easy maintenance.

Quantity production of standard components leaves little installation work on site and facilitates subsequent extension.

The wealth of AEG's experience in building up low-voltage switchboards from factory-assembled panels is at your service.
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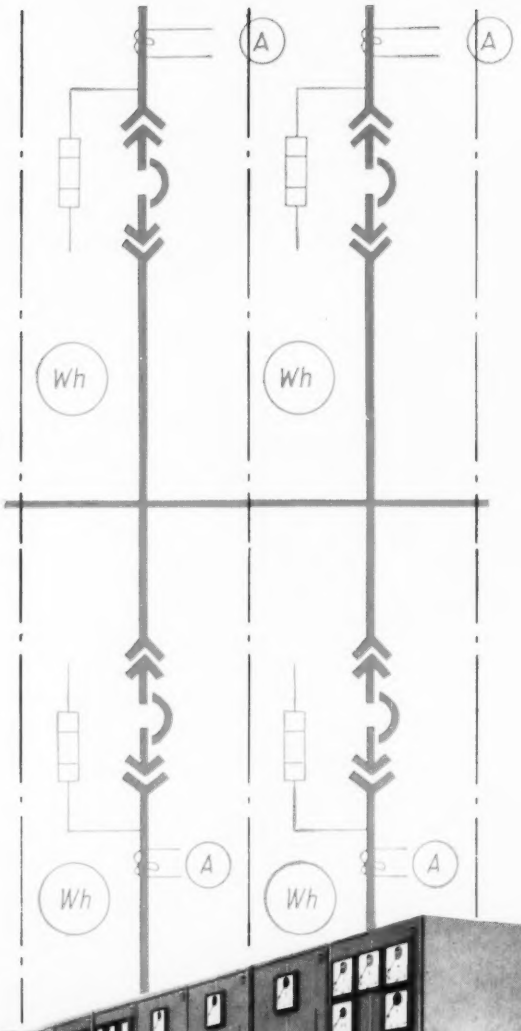
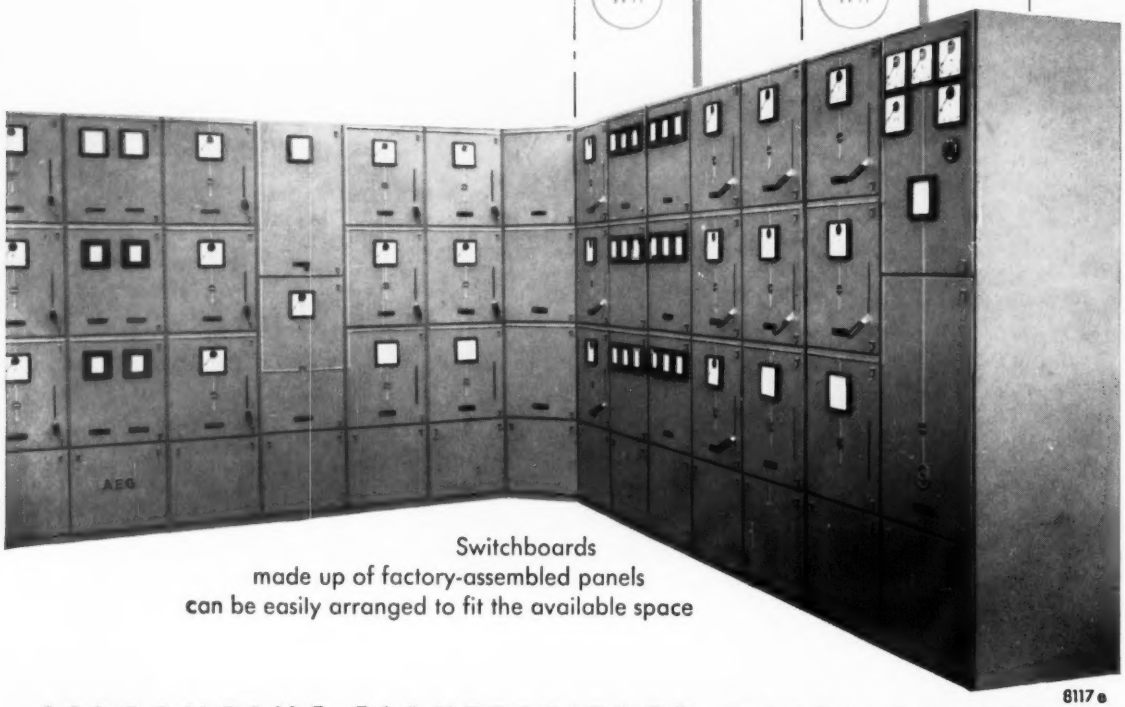



Switchboards
made up of factory-assembled panels
can be easily arranged to fit the available space

8117 e

**ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT**

Berlin (West) EXPORT DEPARTMENT Frankfurt (Main)

For more facts circle 201 on Reader Service Card, p 117

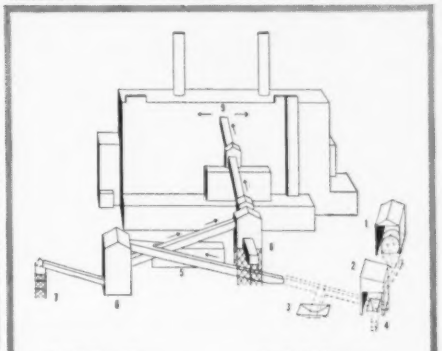
# One "current" cost that's been cut

Graph shows national average price per kwhr for all customers of the electric utility industry. Source: Edison Electric Institute.

**STEADY DIET OF 70,000 TONS A MONTH.** Link-Belt coal handling equipment serves Shawville Station of Pennsylvania Electric Co., one of the ten most efficient steam-electric generating plants in the nation. Engineers were Gilbert Associates, Inc.; Berkebile Bros. were general contractors. Drawing below pin-points equipment.

## *Low-cost coal handling by LINK-BELT helps lower the price of electrical power*

QUALITY-ENGINEERED equipment that handles coal at power plants—through unloading, storing, reclaiming, crushing, sampling, distributing and weighing operations—is an important factor in the cost of producing power. With industry's most complete and reliable line of conveyors and drives . . . plus experience as old as the power industry itself—Link-Belt leads the way to lowest per-ton handling costs. Write to LINK-BELT COMPANY, Dept. AV, Prudential Plaza, Chicago 1, Ill., for our directory, "Link-Belt at Work." You may discover ideas for cutting costs with equipment that delivers extra years of trouble-free performance.



1. Rotary Car Dumper House
2. Car Shaker
3. Truck Hopper
4. Apron Feeders
5. Belt Conveyors
6. Breaker House
7. Refuse Bin
8. Swinging Belt Conveyor
9. Belt Conveyor Trippers

**LINK-BELT**

One source . . . one responsibility for materials handling, processing and power transmission equipment

14,972



For more facts circle 204 on Reader Service Card, p 117

## *speaking of* **Power**

**Priceless reward** to those of us fortunate enough to find our life work in technical publishing is the opportunity to enjoy long and interesting associations with the men and the companies that push forward the frontiers of progress.

A number of things recently have reminded me of this: Reading the fascinating book telling of the first 50 years of Yarnall-Waring Co . . . the 1000th Worthington advertisement in POWER, on the back cover of the March issue . . . writing letters to the presidents of several companies that have been advertising in POWER for 75 years . . . and a news item in this issue on the 75th anniversary of Reliance Gauge Column Co.

**Twin milestones** are passed at Reliance—as the company celebrates its 75th anniversary, J Rowland Brown, president and general manager, marks his 40th. A Life Member and Fellow of ASME, he has long been active in the American Boiler Manufacturers Assn as well, rarely missing a meeting.

As a matter of fact, it was at the last meeting of ABMA that I first learned of this double anniversary and had a long chat with Rowland about the early days of his company and some of the notable changes that have occurred in his 40-year association with it. It was a heart-warming experience and reminded me—if I ever needed reminding—that people are the principal asset of any business.

**Recognition** of just such an asset went on March 1 to Bob Marks, who became Associate Editor of POWER on that date. Those of you who have read Bob's 2-part special report on *Water Treatment* need no convincing that his technical ability and journalistic skill make this promotion one that is richly deserved.

Lon Lowley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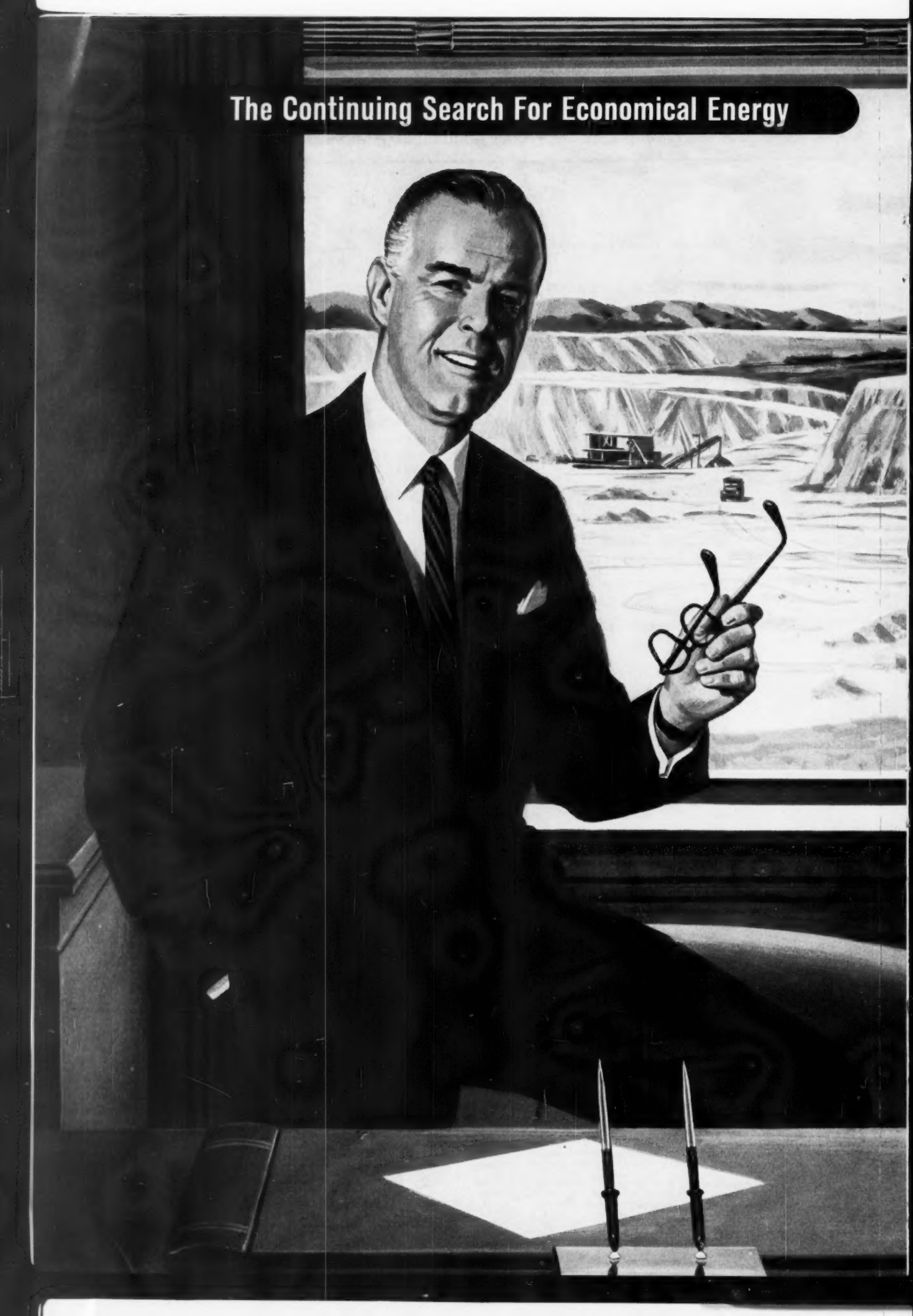
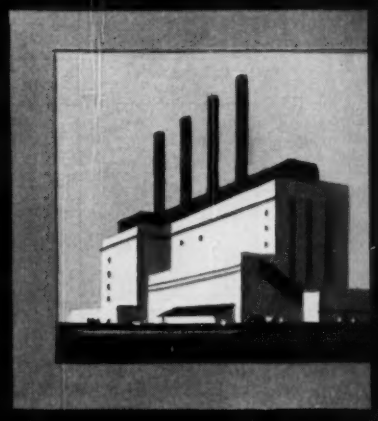

The Continuing Search For Economical Energy



# Do you have a coal mine in your back yard you can't use?

In areas like Florida and the Southwest, where the use of coal has been traditionally prohibitive, utilities are now considering it as an economical, easily available fuel. Why? How is it possible? The answer is B&W research in coal and coal-burning equipment.

At B&W's Research Center, testing of over 33,000 coal samples has provided some important cost-cutting answers—answers that will help you hold the line on operating costs. Important answers that permit building equipment around the fuel you can most inexpensively burn.

What's more, B&W recommendations are completely objective. B&W designs and manufactures all types of fuel burning equipment—for every fuel burning application.

For example, the most economical and satisfactory way to burn lower-grade, high-ash, low-fusion coal, is in the B&W Cyclone Furnace. Less space, fewer burners, more complete fuel consumption, and elimination of fly ash problems are just a few of its many advantages.

We will be glad to discuss your fuel burning problems with you, and to make recommendations based on your special requirements. Write to The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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BOILER DIVISION

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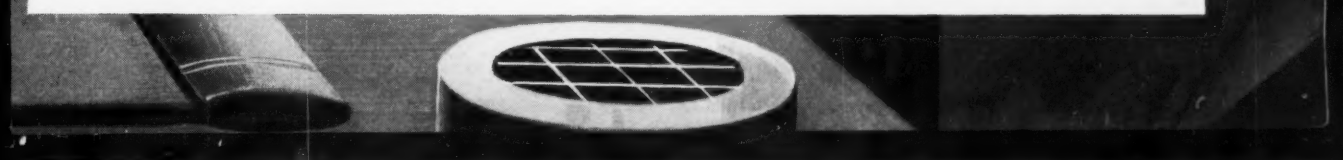

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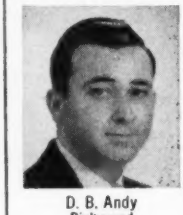
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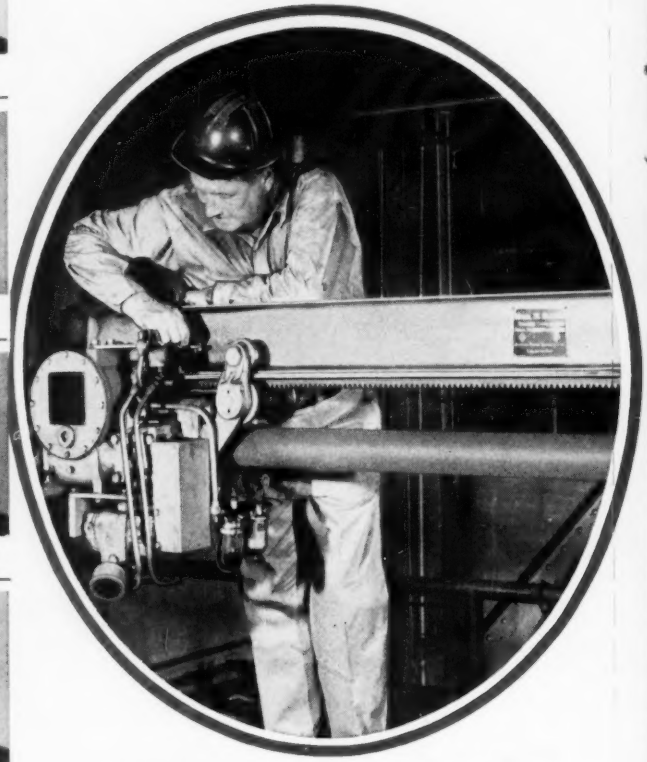


***Diamond Service Engineer making an adjustment on a Model IK Long Retracting Blower to assure maximum cleaning efficiency. Diamond Service is effective preventive maintenance.***

**Circle 205 on Reader Service Card for Preceding Ad**

# FIELD SERVICE ENGINEERS

## A unique field service organization dedicated to giving you

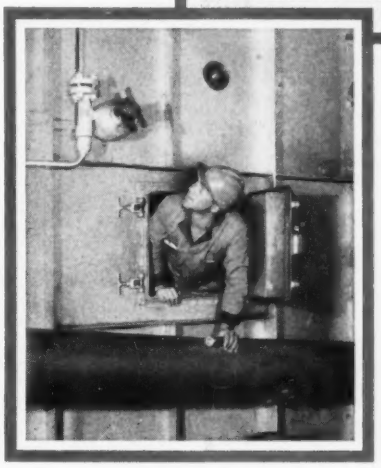
# Better Boiler Cleaning At Lower Cost

The principal duty of these 31 full time, factory trained field service engineers is to insure that Diamond Blowers operate correctly to give you the best boiler cleaning possible and at minimum cost. They are cleaning experts who inspect and adjust Diamond Blowers in stationary (and marine) water tube boilers. This inspection service is rendered regularly . . . unsolicited and without charge.

There is nothing else quite like it in the power industry, and it saves the user of Diamond Blowers money two ways: First, these men often are able to detect potential trouble before it becomes serious or costly . . . preventive maintenance that keeps repair costs down. Second, by seeing that blowers are in good repair and adjustment . . . instructing operators in correct operation and care . . . and by recommending the most efficient and economical blowing schedules, they assure cleaner boilers at lower cost. Boiler efficiency is maintained . . . blowing costs kept down.

This is one of many important plus values you get with Diamond Blowers and Blower Systems.

*Diamond Service Engineer showing operator how his flue gas temperature drops when he uses his blowers correctly and regularly.*



*Diamond Service Engineer makes internal inspection to check cleaning effectiveness of the blowers.*

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8256

**DIAMOND POWER SPECIALTY CORP.**
**LANCASTER, OHIO**
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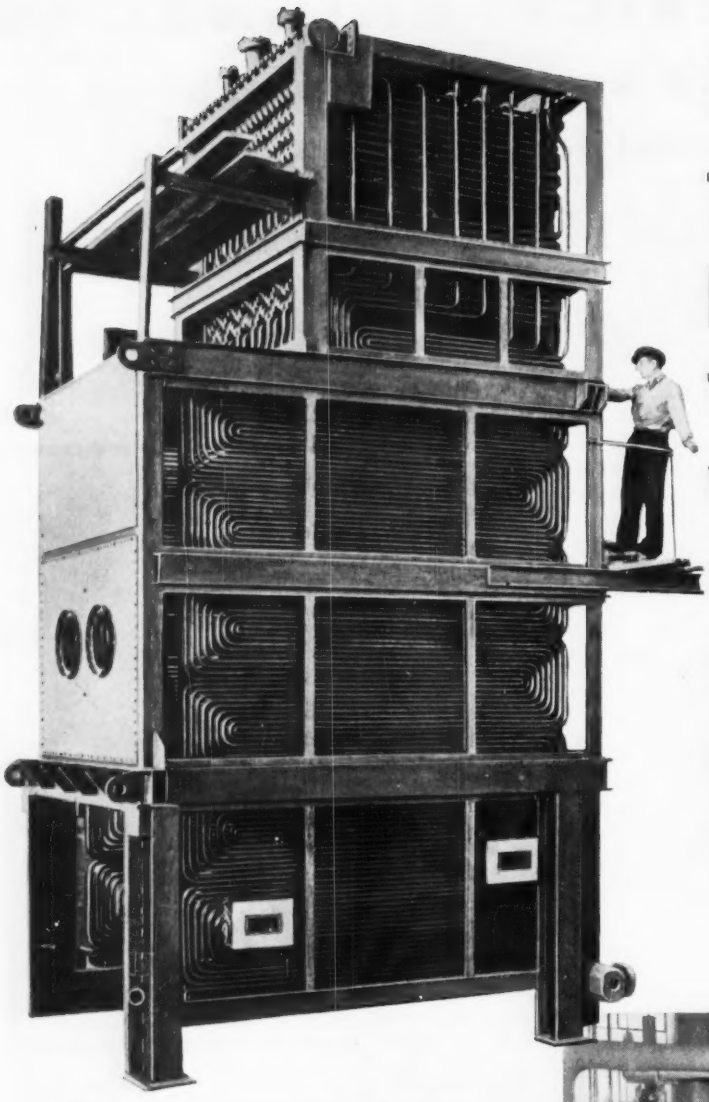
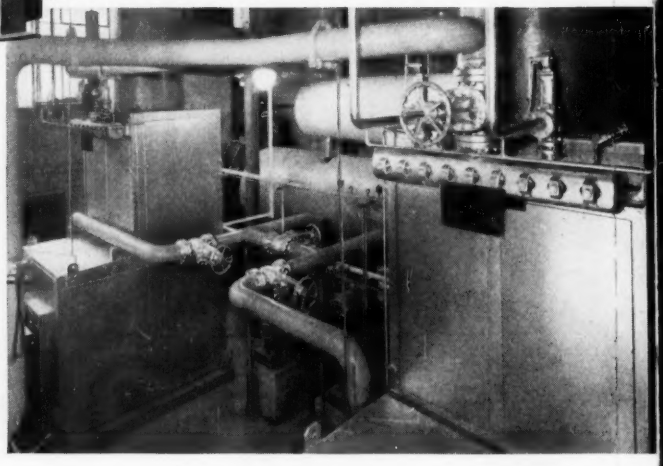
*In new plants large and small...*

# The C-E high temperature water boiler offers savings of 10 to 20%



Shop assembly view showing steel frame and pressure parts for 25-million Btu unit prior to installation of refractory, insulation block, and welded gastight casing.



Compactness of C-E HCC Boilers is demonstrated in this view of two 10-million Btu units installed at a new Michigan high school.

## COMBUSTION ENGINEERING

**Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.**

C-190

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

The list at right points up the versatility and widespread acceptance of Combustion Engineering's HCC boiler. For industrials, schools, institutional use, military bases—wherever there is extensive space to be heated—C-E high temperature water has a place.

Featuring the same principle applied by Combustion in many of its large utility boilers, the C-E LaMont Controlled Circulation Hot Water Boiler offers a compact and effective arrangement of heating surfaces. This design gives precision temperature control, and, dependent upon local conditions, the HCC can save 10 to 20 per cent in maintenance and operating costs—a significant factor when considering a heat source.

Available in a wide capacity range—from 10 to 300-million Btu's—these boilers operate at water pressures up to 500 psi and temperatures to 470 F or higher. The smaller capacity HCC's are completely shop-assembled, while the intermediate and large units are shipped in varying stages of assembly. This C-E practice greatly reduces erection costs.

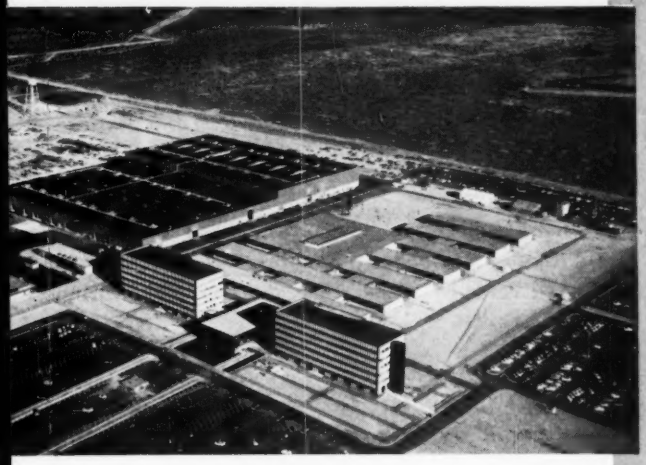
If you are in the market for boilers, either for space heating or process requirements, it may prove greatly to your advantage to investigate C-E high temperature water as your heat source.

Because individual needs vary, *both* steam and hot water have their applications. Combustion Engineering can furnish either, and our engineers are exceptionally qualified to discuss *impartially* with you or your consultants the method most suitable for your situation.

Write for further details on Combustion Engineering's High Temperature Water Boilers.

## Representative list of C-E HCC Boilers in service, under construction, or on order

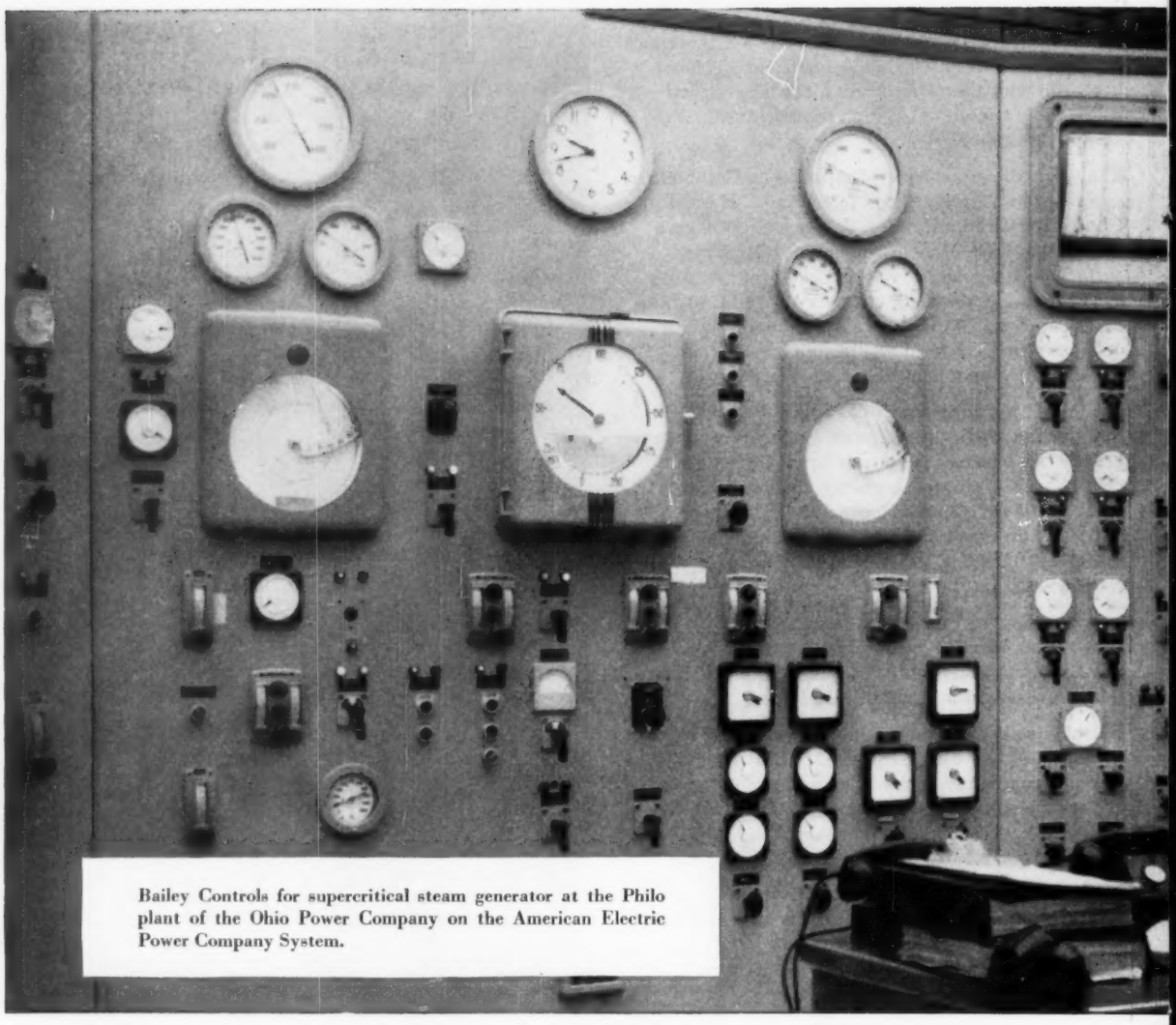
| | No. of Units | Normal Output ea.—Btu/Hr. (millions) | How Fired |
|---|---|---|---|
| A. E. Smith High School<br>Riverview, Michigan | 2 | 10 | Oil |
| J. Bishop & Co.<br>Malvern, Pa. | 1 | 12 | Oil |
| Colorado State College<br>Greeley, Colo. | 1 | 80 | Oil—<br>Nat. Gas |
| Cross Company, The<br>Frazer, Michigan | 2 | 12 | Nat. Gas—<br>Oil— |
| Defense Construction Ltd.<br>Camp Gagetown, N. B., Canada | 3 | 70 | Pulv.Coal—<br>Gas |
| Erie Mining Company<br>Aurora, Minn. | 2 | 65 | Stokers—<br>Oil or Gas |
| Convair Astronautics Div.<br>General Dynamics Corp.<br>San Diego, Calif. | 2 | 30 | Oil—<br>Nat. Gas |
| General Motors Overseas<br>Santos, Brazil | 1 | 12 | Oil |
| Hillcrest Medical Center<br>Tulsa, Oklahoma | 1 | 30 | Nat. Gas |
| Marquardt Aircraft Co.<br>Ogden, Utah | 2 | 12 | Oil—<br>Nat. Gas |
| Michigan State University<br>Oakland, Michigan | 1 | 12 | Oil—<br>Nat. Gas |
| New Florida State Prison<br>Raiford, Florida | 2 | 30 | Oil—<br>Nat. Gas |
| North Carolina Wesleyan College<br>Rocky Mount, N. C. | 2 | 18 | Oil—<br>Nat. Gas |
| U. S. Air Force Academy<br>Colorado Springs, Colorado | 3<br>2 | 100<br>30 | Oil—<br>Nat. Gas |
| U. S. AIR FORCE:<br>Clinton County<br>Air Force Base<br>Wilmington, Ohio | 1 | 16 | Stoker |
| Dover Air Force Base<br>Dover, Delaware | 3 | 50 | Oil—<br>(Fut. Coal) |
| Forbes Air Force Base<br>Topeka, Kansas | 3 | 42 | Oil—<br>Nat. Gas<br>(Fut. Coal) |
| Grand Forks Air Force Base<br>Grand Forks, North Dakota | 2 | 25 | Stokers—<br>Oil |
| McGuire Air Force Base<br>Wrightstown, N. J. | 4 | 50 | Stokers |
| Minot Air Force Base<br>Minot, North Dakota | 2 | 25 | Stokers—<br>Oil |
| Plattsburgh Air Force Base<br>Plattsburgh, N. Y. | 2 | 50 | Oil |
| Portsmouth Air Force Base<br>Portsmouth, N. H. | 2 | 110 | Oil—<br>Nat. Gas<br>(Fut. Coal) |
| Wright-Patterson<br>Air Force Base<br>Dayton, Ohio | 1 | 30 | Stoker |
| Wuthsmith Air Force Base<br>Osceola, Michigan | 2 | 25 | Stokers |
| Air Force Base<br>Torejon, Spain | 3 | 43 | Oil |
| U. S. Navy Auxiliary Air Station<br>Fallon, Nevada | 2 | 15 | Oil |



One of the many large plants using C-E High Temperature Water Boilers is Convair-Astronautics Division of the General Dynamics Corporation. Installed at this new $40-million center for Atlas Intercontinental Ballistic Missile research, development, manufacture, and primary testing are two 30-million Btu HCC Boilers.



For more facts circle 207 on Reader Service Card, p 117



Bailey Controls for supercritical steam generator at the Philo plant of the Ohio Power Company on the American Electric Power Company System.

# Bailey pioneers the control of...

*This is the control center* for the first commercial supercritical pressure, steam-electric unit in America. It went into operation March 20, 1957. Tests made during the first year of operation indicate that this new high pressure unit, with Bailey Controls, is establishing new efficiency records in the conversion of coal to electricity.

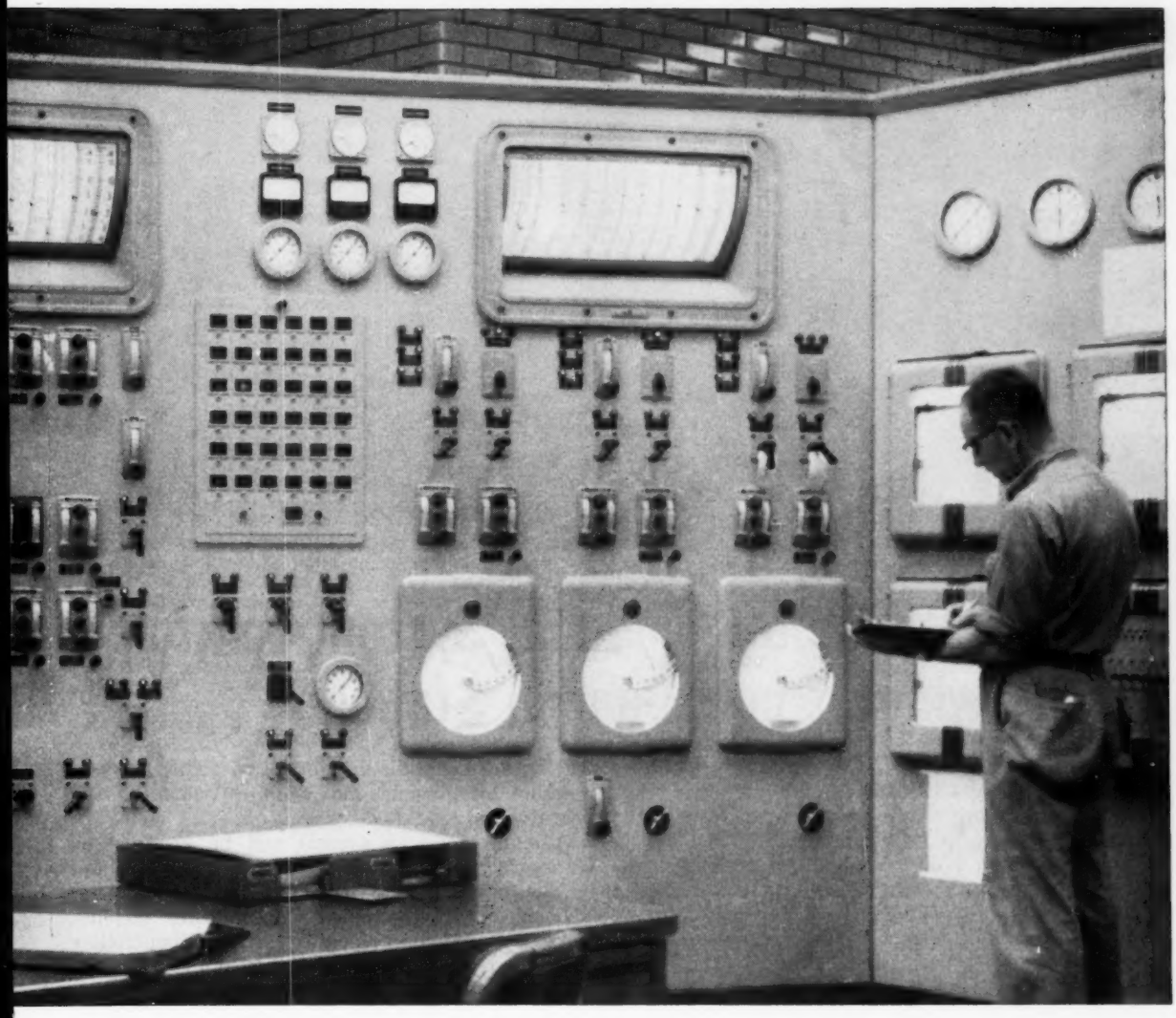
## How it works

"*Once-through*" *steam generating units* must have radically different control systems from those used on drum-type boilers. At Philo, for instance, the Bailey Control for the 4500 psi, 1150F unit, maintains the desired rate of steam generation by means of a feed water flow controller which regulates feed-pump speed.

*In normal operation* this controller is set for a constant rate, and boiler outlet pressure is held to the desired value by automatic regulation of the turbine control valves.

*An alternative operating method* uses the turbine speed governor to regulate turbine control valves and varies feed water flow to maintain boiler outlet pressure.

*With either method* firing rate is varied to maintain final steam temperature. The Bailey System does this by regulating coal and air in parallel, primarily from changes in feed water flow with secondary adjustments, when necessary, from steam temperature.



# SUPERCRITICAL STEAM PLANTS

*Optimum combustion conditions* are maintained by Bailey Oxygen-Combustibles Recorder-Controllers which continuously sample exit gases from each cyclone and automatically adjust coal feeder speeds.

**Seasoned Engineering Experience**

For greater fuel savings, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. And, for your convenience (and to save time and travel expense) there's a Bailey District Office or Resident Engineer in or close to your industrial community.

Arrange to visit a nearby Bailey installation. We stand on our record. A135-2

***Instruments and controls for power and process***

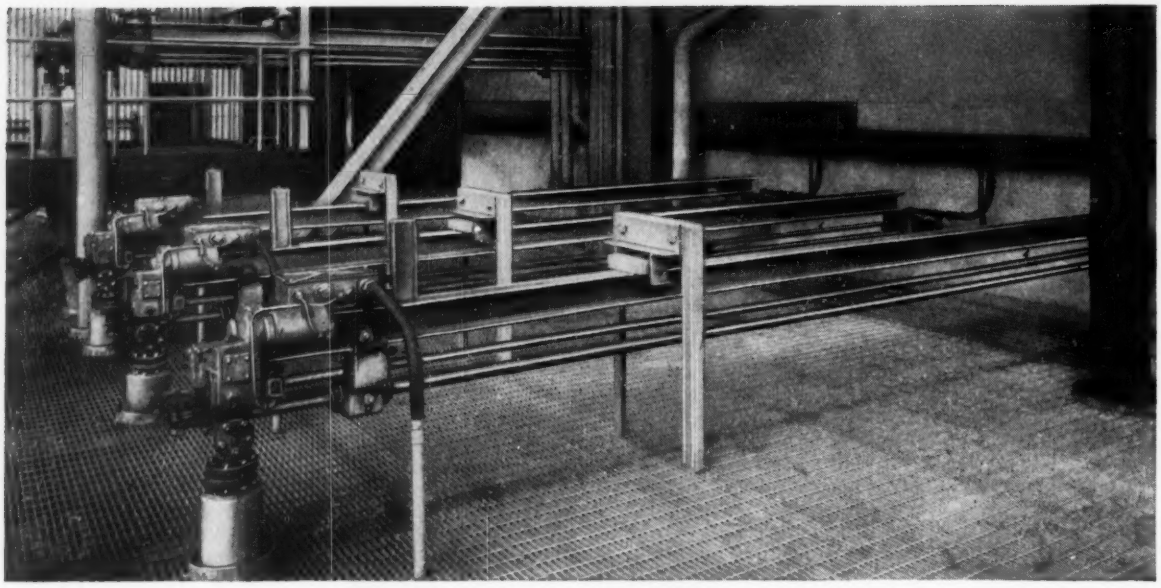
## BAILEY METER COMPANY

**1036 IVANHOE ROAD • CLEVELAND 10, OHIO**

**In Canada—Bailey Meter Company Limited, Montreal**



For more facts circle 208 on Reader Service Card, p 117



# Vulcan Automatic-Sequential System controls soot blowing at new Gannon Station

As the first modern utility boiler in Florida to be fired by coal, Tampa Electric Company's Gannon Station incorporates the most advanced control systems. Unit 1, with its boiler rating at 950,000 pounds per hour at 1760 psig and 1000 degrees F., uses a Vulcan soot blowing system that features both group and unit control.

Vulcan T-3-E long retractable soot blowers with their dual-motor drives clean Gannon's Unit 1 boiler with double-helix patterns for complete coverage. The system includes Vulcan wall deslaggers and rotary soot blowers—all driven by electric motors and using steam as the blowing medium. A Copes-Vulcan diaphragm valve reduces steam pressure for blowing and a Copes-Vulcan motor-operated valve is used for shut-off.

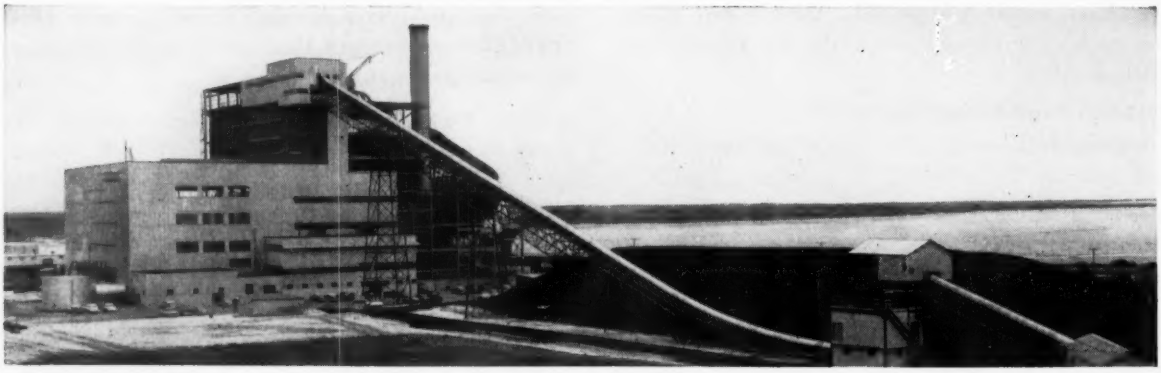
A similar Vulcan system will be installed on Gannon's Unit 2, rated at 950,000 pounds per hour at 1760 psig and 1000 degrees F.

Besides fully-automatic soot blowing systems, Copes-Vulcan offers complete systems for controlling combustion, feedwater, boiler feed pump recirculation, and steam temperature. Whether your boiler is large or small, power or process, Copes-Vulcan can provide a unit or an integrated package, custom designed to your requirements.

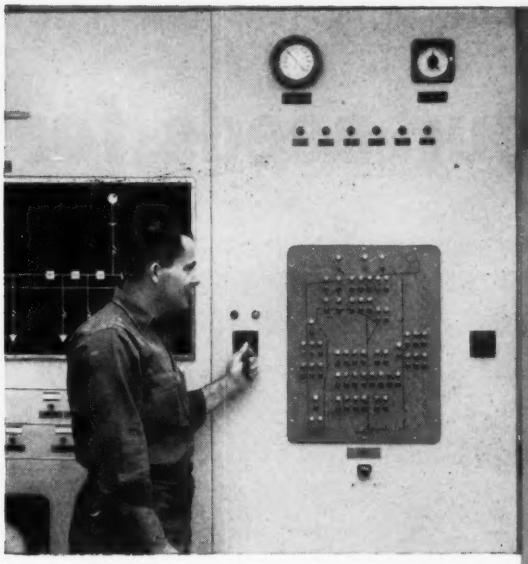
**Copes-Vulcan Division**

**BLAW-KNOX COMPANY**

**Erie 4, Pennsylvania**

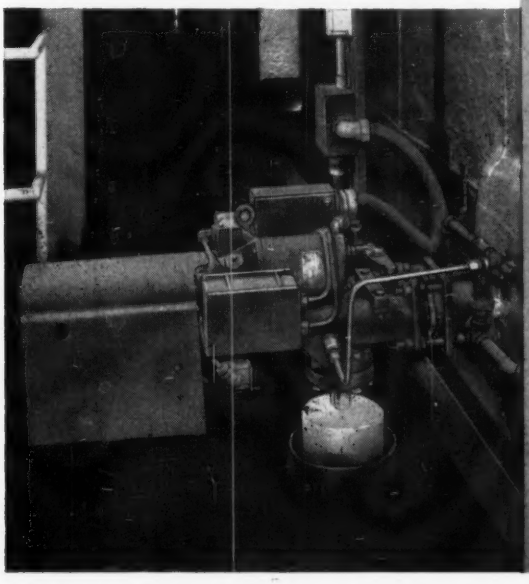


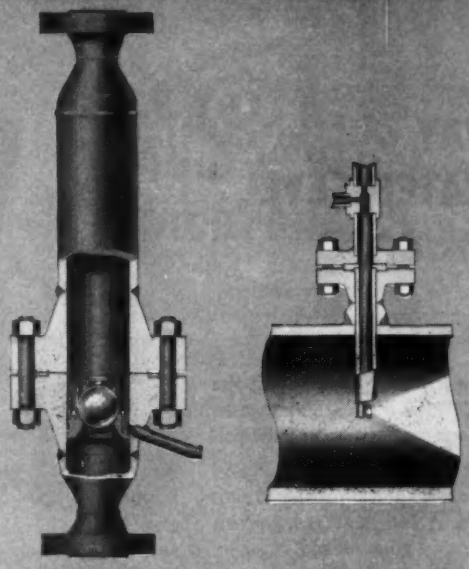
# C-V NEWS NOTES



**Finger tip control for Gannon's operators** . . . with Vulcan's Automatic-Sequential group and unit control. Operator can preselect any number of soot blowers for automatic sequence . . . preselect any number of units or groups of units to be operated individually . . . or switch instantly to single unit operation. Program lights and toggle switches are located on engraved boiler diagram. Automatic-Sequential systems use steam, air or a combination as the blowing medium without a change in equipment. Write for Bulletin 1029.

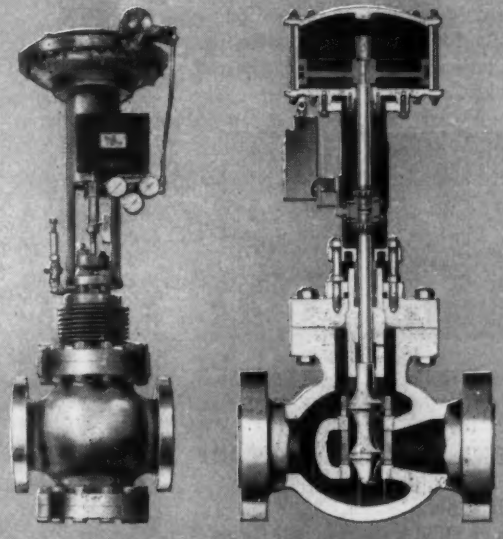
**Wall deslagger conserves steam** . . . minimizes average slag thickness. Vulcan's RW-3E is equipped with dual motors: one to traverse *fast* to get the nozzle to and from the blowing position almost instantly . . . the other to rotate the tube slowly for thorough cleaning. The RW-3E may be installed indoors or out, at almost any angle from side wall, roof or floor. It has only one outside stuffing box, no threads or working parts in the blowing medium to assure easy maintenance. Write for Bulletin 1034.





**Desuperheaters improve temperature control.** Variable-Orifice Desuperheater* (left) uses a weighted steel ball to control orifice opening . . . holds reduced steam temperature constant only twenty feet downstream from desuperheater outlet, even over a 50-to-1 load range. Bulletin 1037. *Patent Applied For

**Steam-Assist** (right) meets all specifications for conventional steam-atomizing type yet normally uses assisting steam only on light loads where control is most difficult. Mechanical-atomizing types also available. Bulletin 1024-A.



**Versatile regulator valves offer new simplicity of design.** Diaphragm-type CV-D (left) is designed for remote control service. It can be direct or reverse acting, has excellent rangeability. Piston-type CV-P (right) is designed for high-duty service . . . assures maximum power with precise positioning.

**All Copes-Vulcan valves** are tailored to the job. The style of valve port is selected to provide optimum control for specified operating conditions. Bulletin 1027.



For more facts circle 209 on Reader Service Card, p 117

# What are your needs for

## YARWAY COLOR-PORT WATER LEVEL GAGE

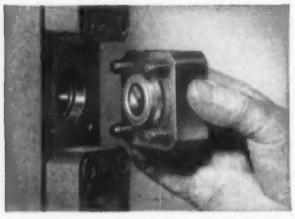
two-color readings
low maintenance
increased availability

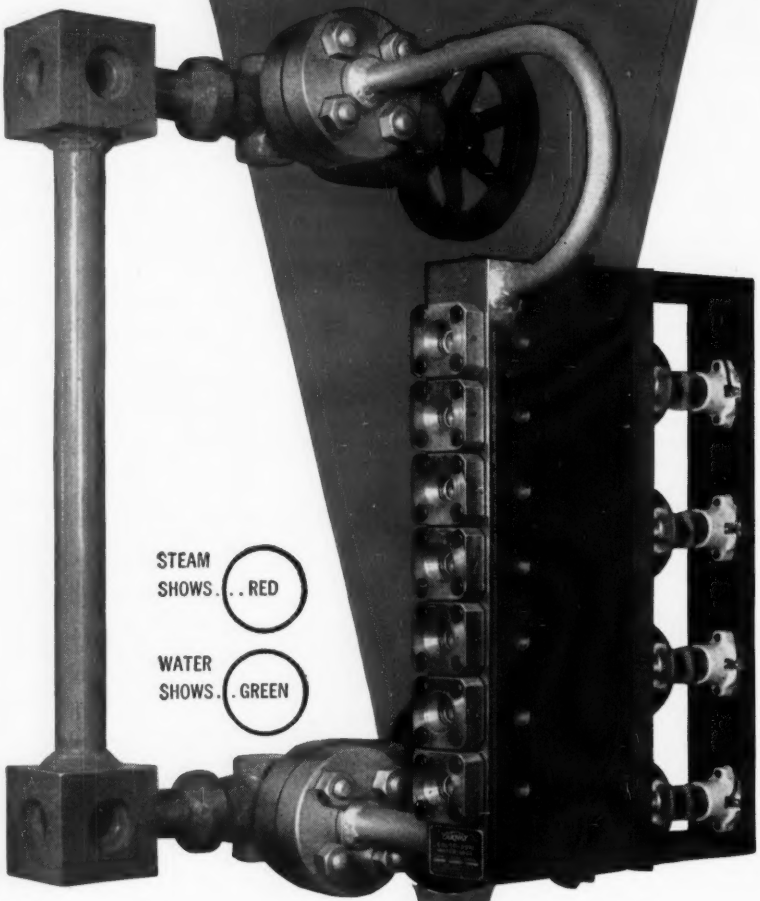
You get a *triple advantage* with the Yarway COLOR-PORT boiler water level gage for pressures to 3000 psi.

*Two-color readings* are brilliant and clear. Water shows green; steam shows red. A full gage is all green and an empty gage all red.

*Low maintenance* with individual cover-glass assemblies, each held solidly in place by four socket head cap screws. "Floating assembly" design applies safe, predetermined loads on glass ports, reducing thermal shocks, permitting faster warm-up.

*Increased availability* means longer service life. Cover glass assemblies can be *serviced in place*, easily and quickly.





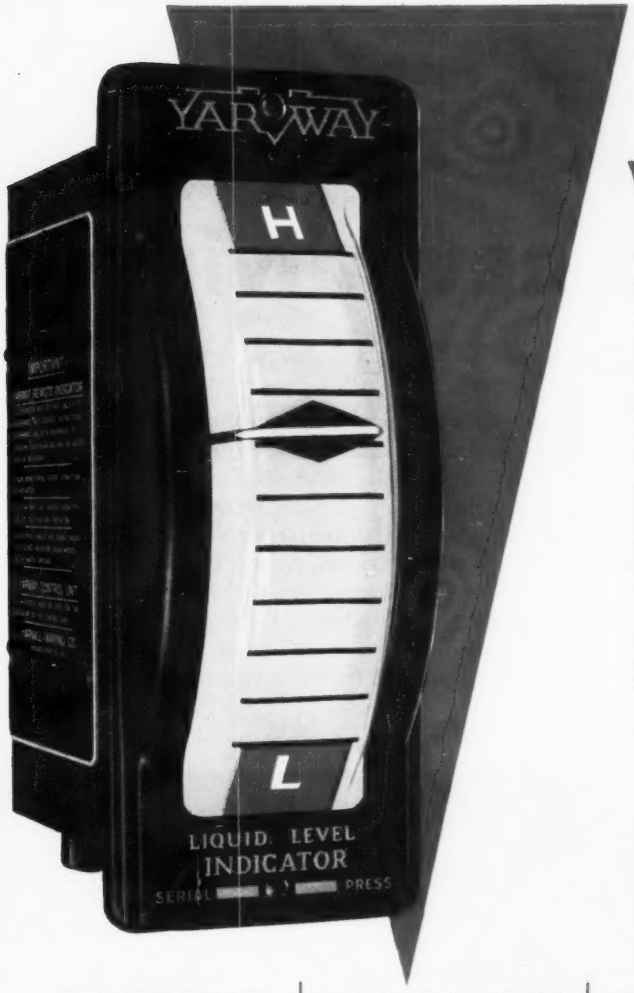

Yarway Bulletin WG-1814 describes the Color-Port Gage. Write for it.

**YARNALL-WARING COMPANY**
100 Mermaid Avenue
Philadelphia 18, Pa.
Branch Offices in Principal Cities

YARWAY COLOR-PORT

*. . . a good way to specify high pressure water gages*

# boiler water level indication ?




## YARWAY REMOTE LIQUID LEVEL INDICATORS

Boiler water levels and other liquid levels requiring remote indication can be handled completely by a Yarway system.

Heart of the system is the Yarway Remote Liquid Level Indicator that gives instant, accurate readings because the mechanism is operated by the boiler water or other liquid itself. The pointer mechanism is never under pressure. Clear, "wide vision" face permits easy readings from any angle.

The Yarway Indicator conforms with A.S.M.E. Boiler Code Committee ruling (Case #1155) permitting two independent remote level indicators of compensated manometric type to replace one of two required gage glasses for boiler pressures 900 psi and above.

Electronic Secondary Indicators can be added at any point in the plant. Remote Hi-Lo Alarm Signals (lights and/or horns) can be connected for additional safety.

Primary indicators fully compensated for every pressure change in boiler also available.

For permanent record of changing levels, the Yarway Hi-Lo-Graph Recorder can be furnished.

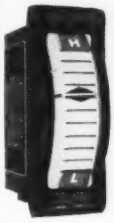
Over 10,000 Yarway Remote Indicators have already been installed. For full details, write for Yarway Bulletin WG-1824.

**YARNALL-WARING COMPANY**
100 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

**FULLY COMPENSATED INDICATORS**

for completely accurate indication under every boiler operating condition

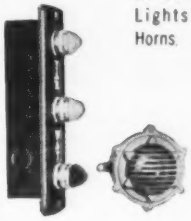
**ELECTRONIC SECONDARY INDICATORS**



To supply additional indication at any point without pressure connections.

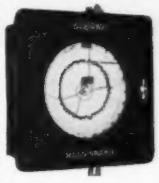
**REMOTE SIGNALS**

Hi-Lo Alarms Lights and/or Horns.



**RECORDERS**

To provide permanent 24-hour record of liquid levels.



YARWAY

*. . . a good way to specify remote liquid level indicators*



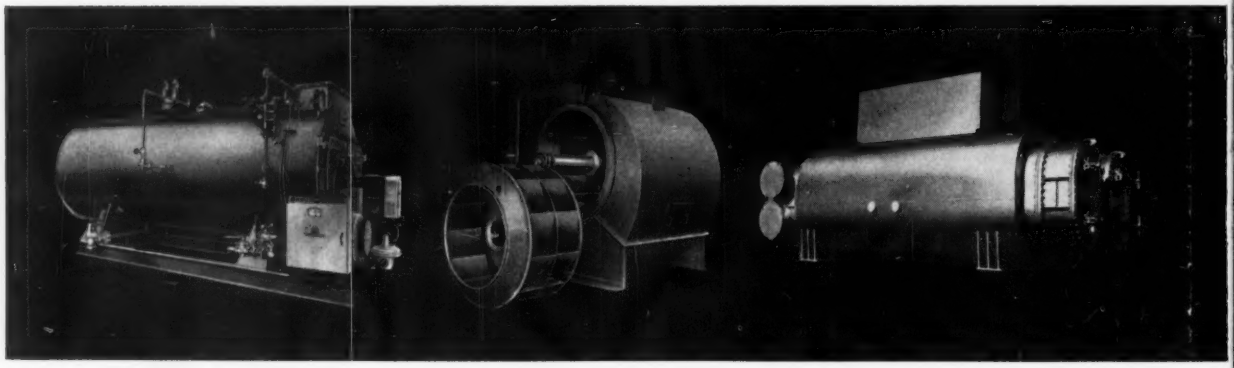
For more facts circle 210 on Reader Service Card, p 117

# To serve you better we created a new division

Now you can benefit from the combined engineering backgrounds and product lines of three American-Standard* divisions—American Blower, Ross Heat Exchanger, and Kewanee Boiler—consolidated into *one* organization!

Here is *one-source* responsibility for quality and performance in equipment that is designed, engineered, and manufactured to work together. You draw from a product line unsurpassed in the industry . . . one that encompasses air conditioning, heating, ventilating, heat transfer, dust collection, and fluid drives.

There are engineer-staffed offices in all principal cities to work with architects, consulting engineers, and contractors with equipment selection and on-the-job problems. We welcome the opportunity to serve you. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.



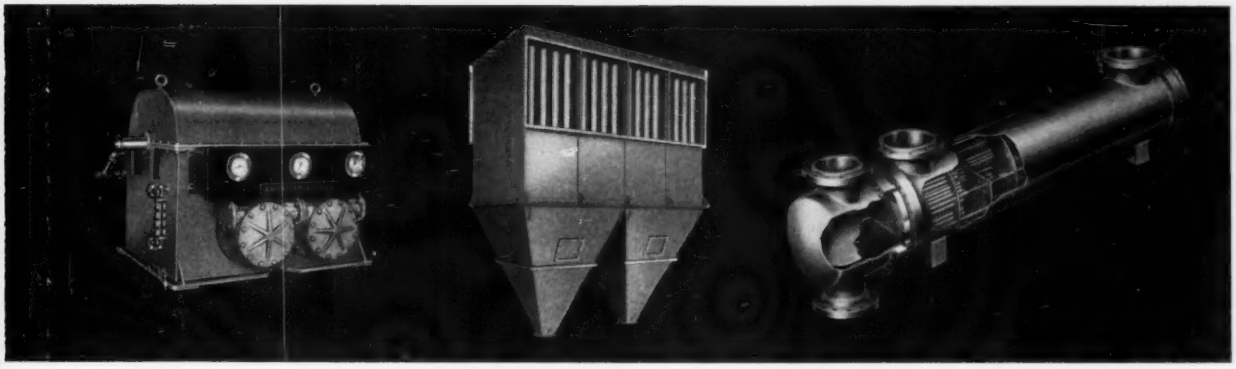
Firebox, scotchtype, and package boilers for heat, steam, and industrial power.

Mechnical draft fans for induced and forced draft duty in power plants.

Balanced-flow surface condensers for condensing turbo-generator exhaust steam.

# AMERICAN-Standard
## INDUSTRIAL DIVISION

AMERICAN BLOWER • ROSS • KEWANEE



Fluid drives for adjustable-speed control of feed-pump flow and fan volume.

Dust collectors and precipitators for recovering fly ash, eliminating dust.

Standard and engineered heat exchangers and feedwater heaters for every duty.

*AMERICAN-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

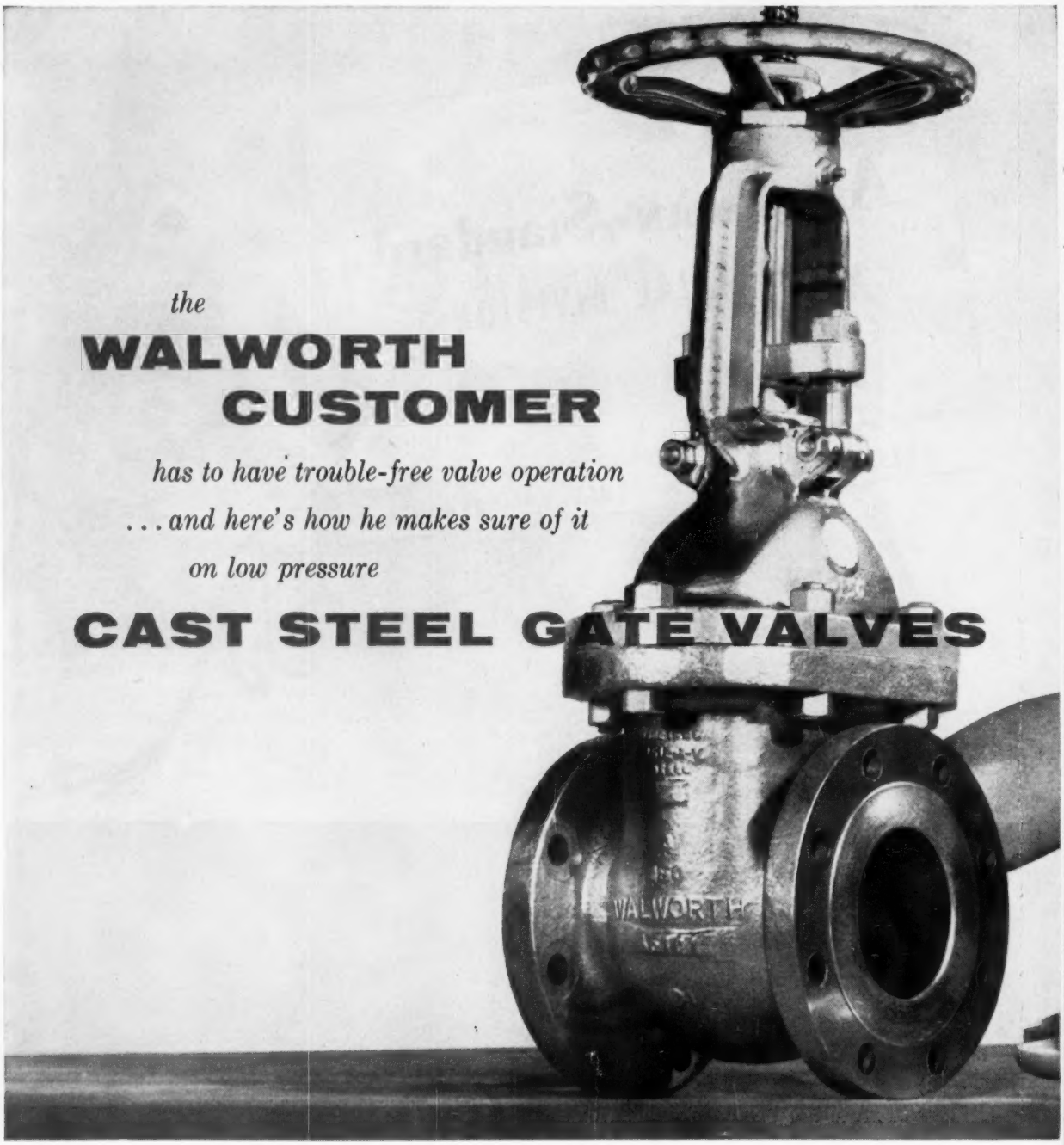
AMERICAN-Standard PRODUCTS

AMERICAN-Standard
INDUSTRIAL DIVISION

AMERICAN BLOWER PRODUCTS • ROSS PRODUCTS • KEWANEE PRODUCTS



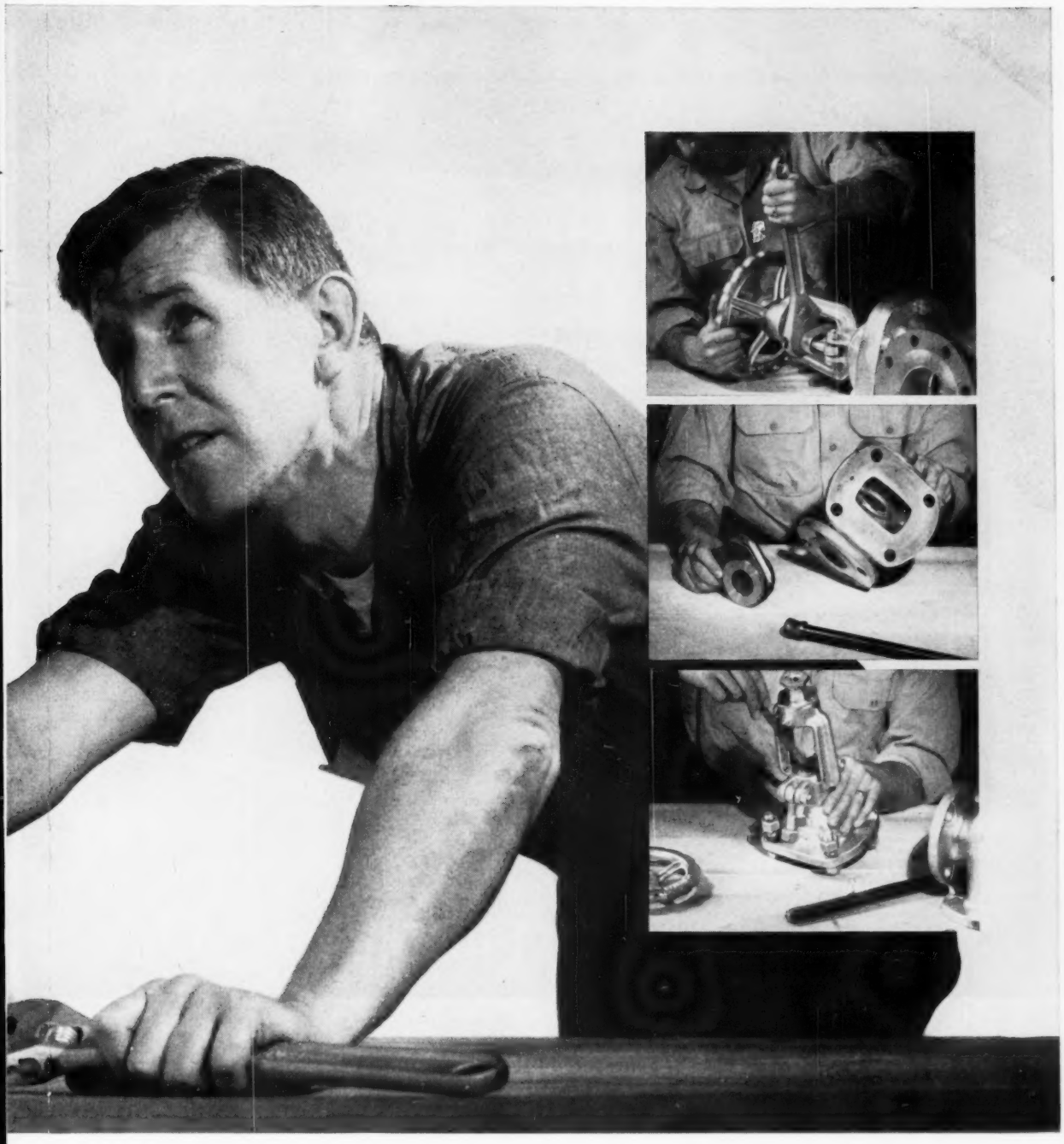

For more facts circle 211 on Reader Service Card, p 117




Before the Walworth Customer makes his decision on cast steel valves he gets persistently curious about things like these: What features reduce turbulence and pressure drop? Can body-to-bonnet joint be reassembled in the field without danger of misalignment? Is stuffing box deep enough to assure tightness and maximum life of packing?

In the Walworth Cast Steel Gate Valves he finds streamlined ports to fight turbulence and pressure drop. He finds flat gasket and male-and-female joint closures that assure correct realignment in field or shop reassemblies. He finds stuffing box depth adequate-plus for tightness and packing durability.

It's for customers like this man that



Walworth exists. We know he's hard to please, and we're proud to please him. If his exacting buying standards in valves are yours, too, we'd like you for a Walworth Customer. For details on all types and ratings of Walworth Cast Steel Gate Valves, or any of the complete line of Walworth Valves, contact your Walworth Distributor.

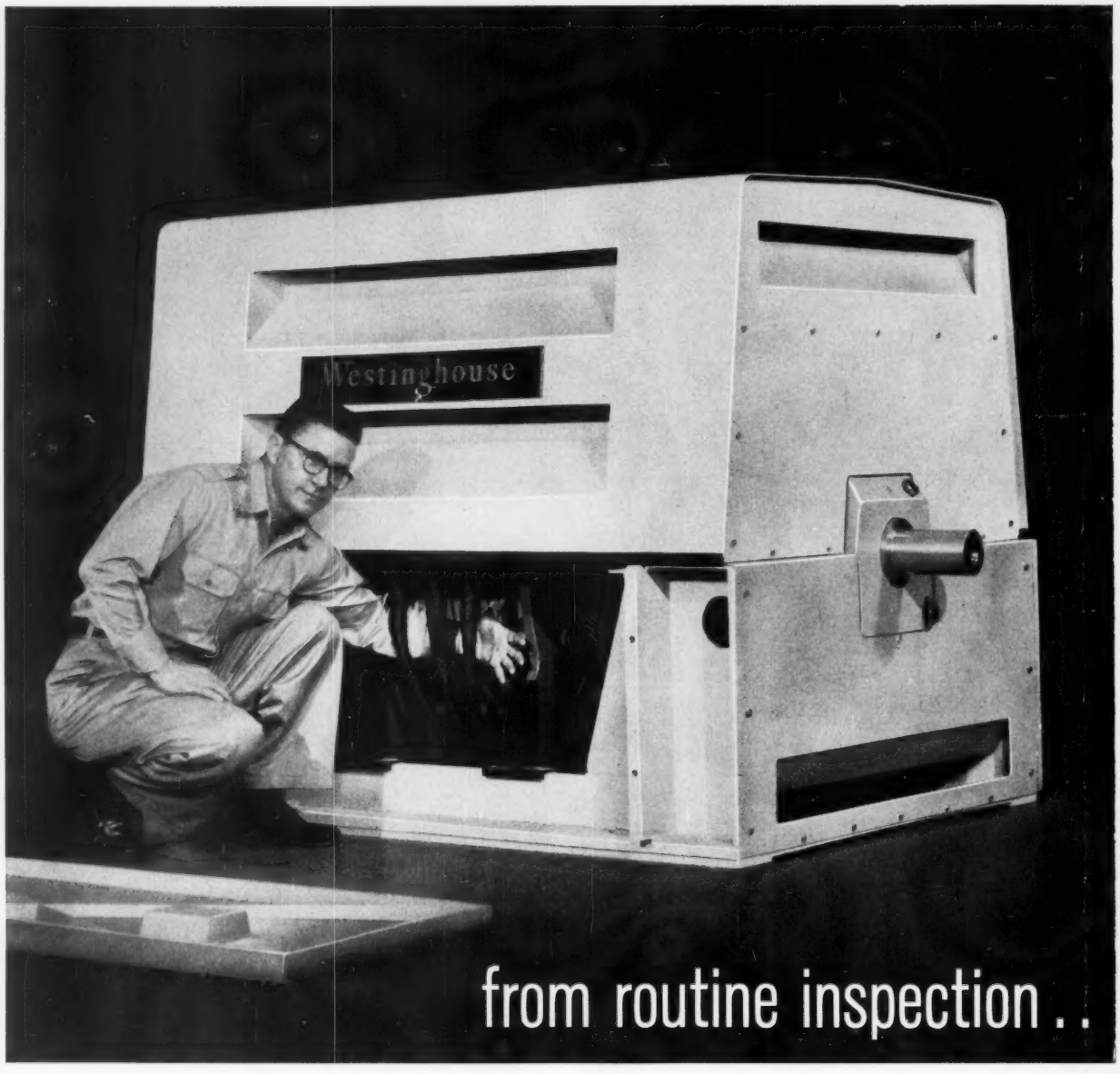
*Or write* **WALWORTH** *750 Third Avenue, New York 17, N. Y.*

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

***WALWORTH SUBSIDIARIES:*** ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.



**For more facts circle 212 on Reader Service Card, p 117**



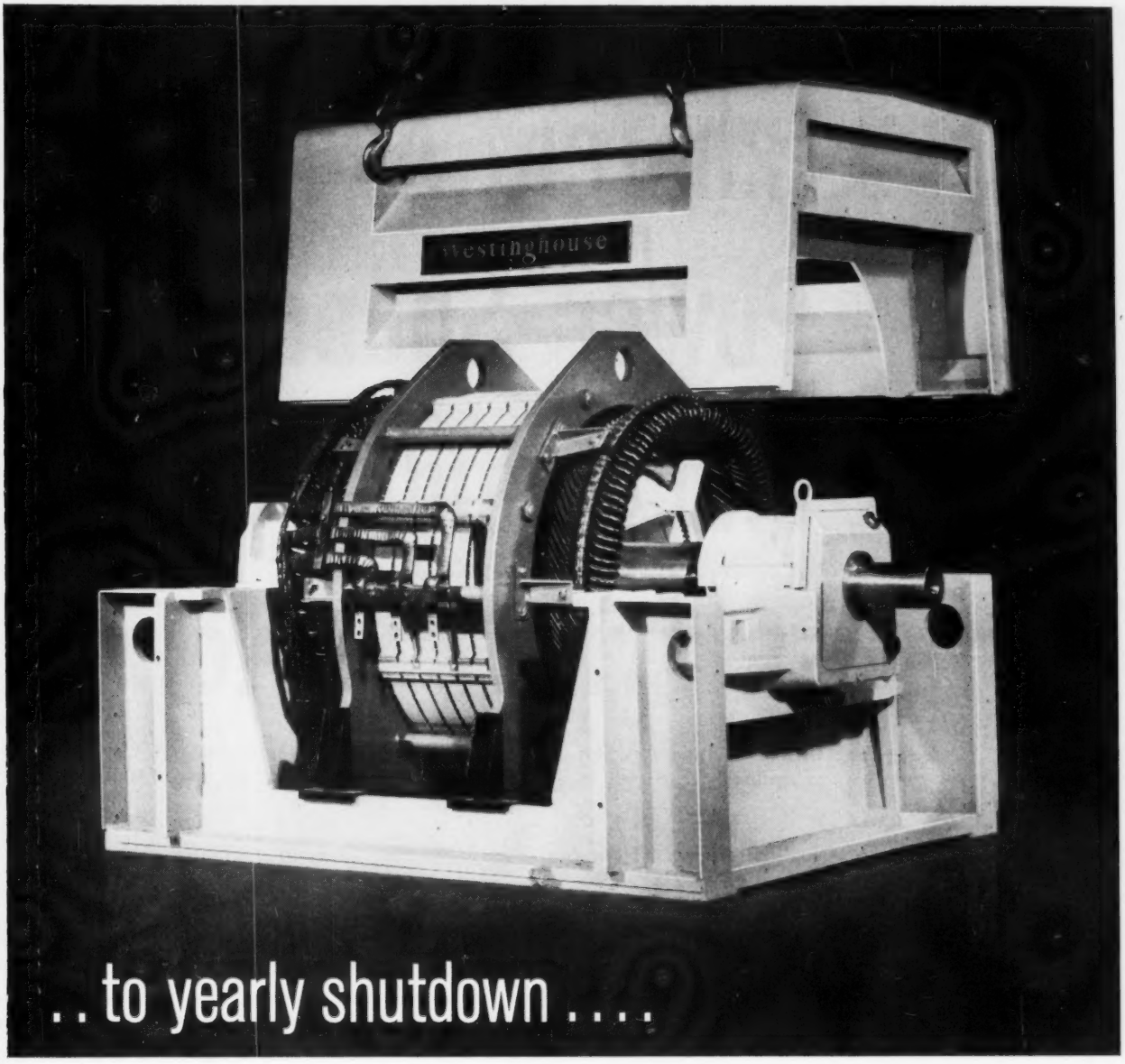

# the F/A Motor saves you time and money!

Scheduled inspections and cleanings that result in longer life for your large motors are now easier, less expensive and—for the first time—accomplished with motor parts in *full view!*

The Westinghouse F/A Motor can be prepared for routine inspection, examined, and be back in operation in 10 minutes. For planned yearly inspections, complete disassembly and reassembly take only an hour.

**Routine or Weekly Inspection.** It takes just three minutes to prepare for this inspection. Merely removing the side panel completely exposes the leads, winding ends and rotor air ducts. A quick cleaning takes care of any contaminants. In four minutes the side panel is back on, and the F/A Motor is in operation.

**Detailed Annual Inspection.** Such a complete disassembly as is shown at the right, above, is rarely done, because in conventional motors it is virtually impossible. However, with the Westinghouse F/A Motor it *can* be done, and in just half an hour! No other housing design permits such




see-ability and accessibility. Here you can *completely* check windings and bracing, examine the ends of the rotor, check the condition of the *total* core and check all bolts for security. Necessary cleaning can be done in minutes, and with a thoroughness heretofore impossible. Then, in roughly 30 minutes, reassembly of side panels, top air shields, end covers and top enclosure puts the F/A Motor back "on the line."

For full information on the long service life, reliability and accessibility of the Westinghouse F/A Motor, call your Westinghouse representative or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. J-15003

## CHECK THESE BONUS VALUES IN THE F/A MOTOR

- Full Accessibility
- Inherently Quiet—housing and stator separated
- Thermalastic® Insulation—recognized as the finest
- Time-Proven Components—longer, more efficient life
- Easy Connection—conduit boxes eliminated

YOU CAN BE **SURE**...IF IT'S

# Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

# YOUR *FISHER/MAN* STANDS BEHIND THIS

# FOR Inherent Accuracy–Power–Speed–and Stability

## FISHER TYPE 470 P.O.P.

- Delivers same power in either direction at any point of the stroke.
- No air set required—utilizes clean, noncorrosive air or gas up to 150 psi.
- Adaptable to virtually all types of valve bodies including Butterfly valves.
- Easily reversible actuator can be changed in the field.

This small, compact, pneumatically operated piston is available in five sizes with yoke sizes to fit any of the Fisher valve bodies including Butterfly valves. P.O.P. acts with high speed. For example, the 8½-inch size gives you 1.5 inches per second stroking speed. Write Fisher Governor for Bulletin E-59.

| Type 470 P.O.P. With Fisher Bodies | | | | |
|---|---|---|---|---|
| Cylinder Size, Inches | Yoke Boss Size, Inches | Valve Body Size, Inches | Stem Size, Inches | Allowable Stem Force, Lbs. |
| 4¾ | 2⅛ | ½—1½ | ⅜ | 1,500 |
| | 2 13/16 | 2—4 | ½ | * |
| | 3 9/16 | 5—8 | ¾ | * |
| 6⅛ | 2 13/16 | 2—4 | ½ | 2,500 |
| | 3 9/16 | 5—8 | ¾ | * |
| 8½ | 3 9/16 | 5—8 | ¾ | 5,000 |
| 10¾ | 5 | 10—16 | 1 | 8,000 |
| 13 | 5 | 10—16 | 1¼ | 12,000 |

*Limitation with these stems is dependent upon the maximum force available from each cylinder.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

**FISHER GOVERNOR COMPANY**

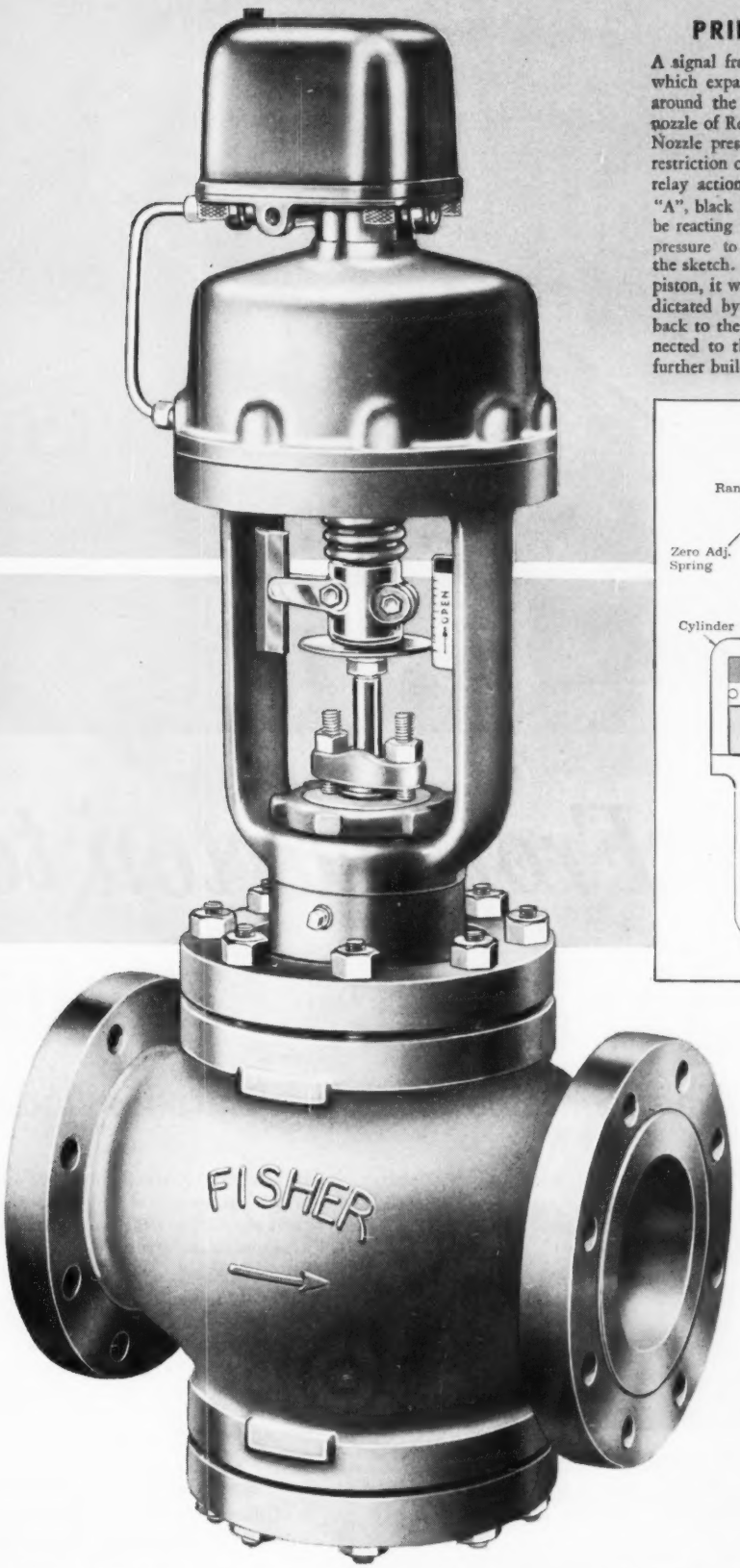
Coraopolis, Pa. / Woodstock, Ontario / London, England

*Main Office and Plant: MARSHALLTOWN, IOWA*

FISHER® Controls

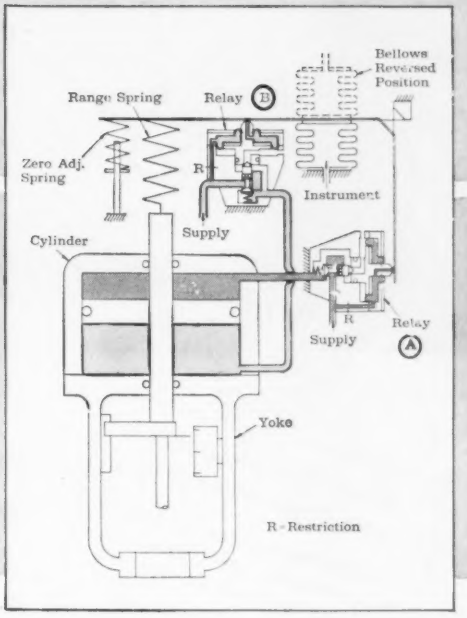
SINCE 1880

# PNEUMATICALLY OPERATED PISTON...




## PRINCIPLE OF OPERATION

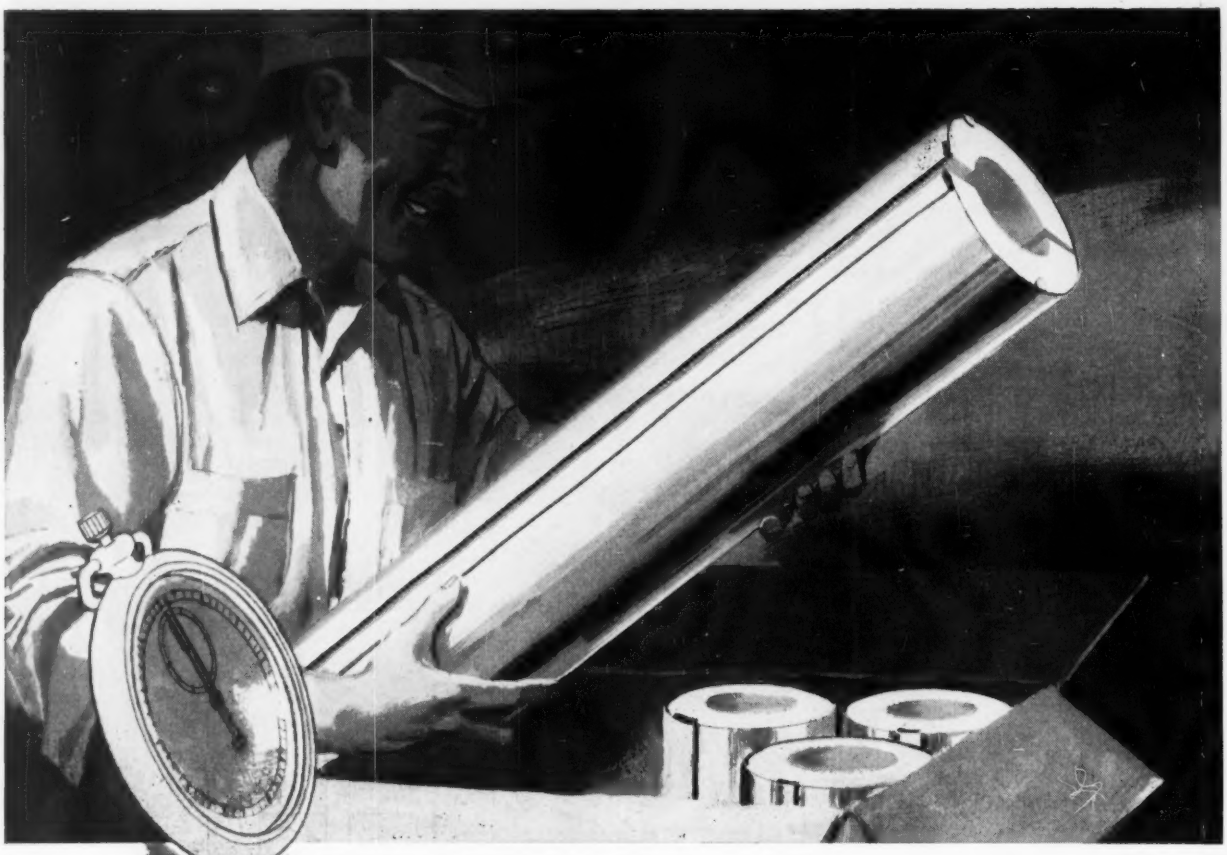
A signal from the controller is received by the bellows which expand to move the beam. The beam will pivot around the fixed point and simultaneously uncover the nozzle of Relay "B" and cover the nozzle of Relay "A". Nozzle pressure will increase in Relay "A" due to the restriction created by the beam over the nozzle. Through relay action, the air pressure to the top of the piston, "A", black in the sketch, will be increased. Relay "B" will be reacting to the change in beam position to decrease the pressure to the under side of the piston, "B", red in the sketch. Due to the unbalanced pressures acting on the piston, it will move down, changing the valve position as dictated by the controller. The piston movement is fed back to the beam by means of a range spring that is connected to the piston rod extension, thus preventing any further build-up of pressure in the cylinder.




Exterior view of high pressure actuator. Type 470 mounted on a Design "A" body.



For more facts circle 214 on Reader Service Card, p 117



**Now! Ready-to-install in a single package—**

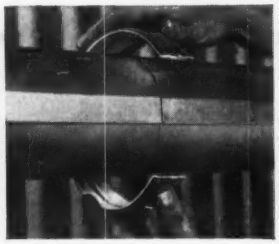
- **High-temperature insulation**
- **A protective metal jacket**
- **A built-in vapor barrier**

The insulation in Metal-On is Johns-Manville Thermobestos® . . . finest of all the calcium silicate insulations for service to 1200°F.

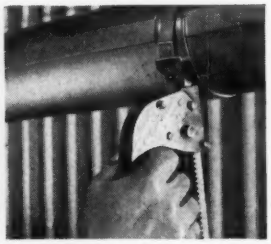
# *From carton to . . . with*

## Thermobestos calcium silicate insulation

**5 SECONDS TO REMOVE** Metal-On from carton. Another 25 seconds to snap on pipe and lock in place!



**15 SECONDS LATER** the specially designed aluminum "snap strap" (containing vapor seal) has been snapped on joint.



**METAL BAND** provides perfect joint protection against vapor and weather. Total elapsed time: 90 seconds!

**Here's the fastest, most efficient way ever to install high-temperature pipe insulation and protective aluminum jacketing.**

Metal-On is the insulation idea all industry has asked for: a single package product that permits application of Thermobestos pipe insulation and corrosion-resistant metal jacket in one fast operation. You'll find that a section of Metal-On can be applied as fast as, oftentimes faster than, an insulation alone.

**Snaps in place . . . F-A-S-T!**

J-M's new Metal-On consists of Thermobestos calcium silicate insu-

Metal-On ends jacket thickness and alloy guesswork! The Metal-On jacket measures an ideal .016-inch thick . . . of a high-quality aluminum alloy selected for superior weather resistance.

# *pipe in 90 seconds!*

# new J-M METAL-ON Insulation!

## factory-jacketed in gleaming, weatherproof aluminum

lation, a vapor barrier and an all-weather protective covering of aluminum. Furnished ready-to-install, a section of Metal-On snaps on the pipe, locks tightly in place (new locking device is exclusive Metal-On feature) to seal out weather and protect the insulation indefinitely. Joints are sealed tight with aluminum "snap straps" mechanically fastened in place with metal bands.

**Right alloy . . . proper thickness**

The Metal-On aluminum jacket reduces maintenance in virtually every outdoor pipe application! It never needs painting . . . won't rust . . . is impervious to surface dirt, oils and grime. The jacketing is made of an aluminum alloy (containing magnesium) that is specially selected for superior corrosion resistance. Jacket thickness is designed to provide, at lowest cost, outstanding appearance, stiffness, workability and resistance to abuse and pitting.

Metal-On presents no fitting problem. It is cut easily right on the job with either power or hack saws. Available in 36″ sections in a complete range of pipe sizes through 24″ . . . by 3″ thickness.

To help you investigate Metal-On for your next pipe insulation requirement, let us send you the informative brochure, IN-217A. Write for it today. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

**JOHNS-MANVILLE**

JOHNS-MANVILLE JM PRODUCTS

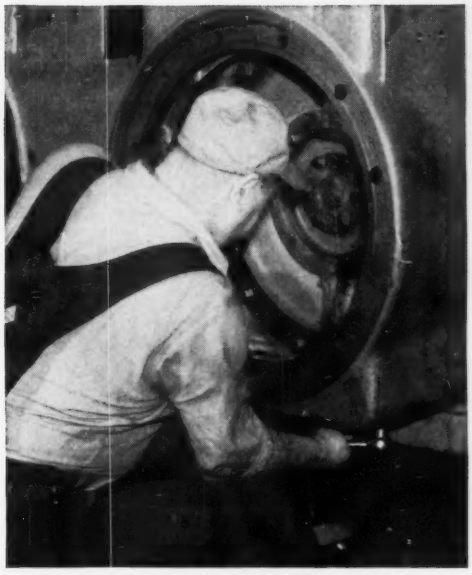


For more facts circle 215 on Reader Service Card, p 117

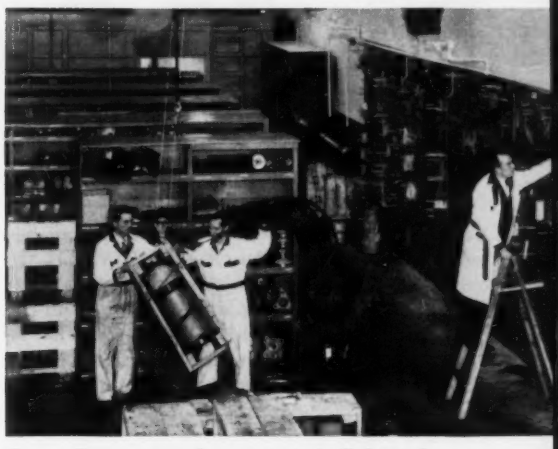
Edmund S. Budd, *Manager of Parts Division,*
*The Cooper-Bessemer Corporation, points out that...*

# You are this near to Cooper-Bessemer service!

*Cooper-Bessemer engineers are ready to assist you in planning power or compression facilities, or solving operating problems.*



*Experienced Cooper-Bessemer field technicians assist you in installation and servicing of equipment.*



*Cooper-Bessemer warehouses, strategically located, provide replacement parts for speedy servicing and peak availability of your facilities.*

WHEN YOU INVEST in Cooper-Bessemer engines, compressors or controls, our service facilities are as close to you as the telephone... night and day! We serve you in these three important ways:

**Technician service.** Our skilled installation and maintenance crews are permanently located in areas throughout the country, ready to assist you, to assure top economy of operation and availability of your Cooper-Bessemer equipment.

**Warehouse service.** We maintain an extensive inventory of replacement parts for Cooper-Bessemer products in strategic locations to give prompt attention to your needs.

**Engineering service.** As new or changed conditions arise, our experienced field service engineers can give you on-the-spot recommendations. And they are backed up by the strong team of Cooper-Bessemer engine and compressor engineers in Mount Vernon.

The superiority of Cooper-Bessemer Service can save you thousands of dollars yearly in capital investment and in operating cost. Make sure you take this important *plus value* into account when you specify and buy engine and compressor facilities.

*BRANCH OFFICES:* Grove City • New York • Washington Gloucester • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa New Orleans • Shreveport • Houston • Greggton • Dallas • Odessa Pampa • Casper • Seattle • San Francisco • Los Angeles

*SUBSIDIARIES:* Cooper-Bessemer of Canada, Ltd.... Edmonton Calgary • Toronto • Halifax
C-B Southern, Inc.... Houston
Cooper-Bessemer International Corporation... New York • Caracas Mexico City

Cooper Bessemer

**GENERAL OFFICES: MOUNT VERNON, OHIO**

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN

**For more facts circle 216 on Reader Service Card, p 117**

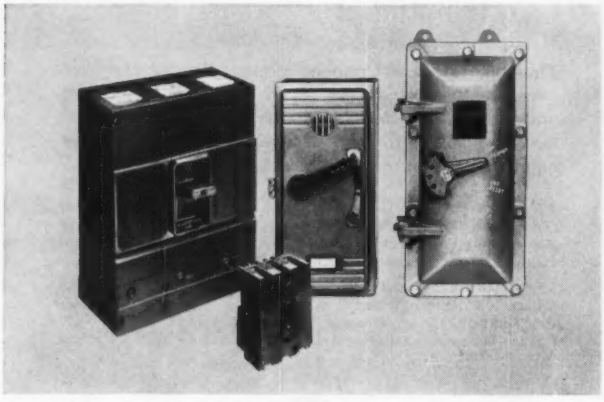
# I-T-E CIRCUIT BREAKER COMPANY

# SAFETY

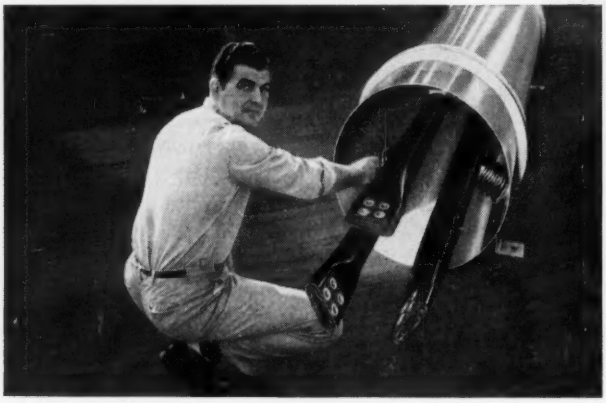
Yes, there's real economy in fused power switching centers, but make sure you also get the *extra safety* only I-T-E offers. In every I-T-E Power Switching Center, you have the assurance of knowing that switches can be closed *even into a fault* with complete safety for both personnel and equipment. Toggle-snap quick closing prevents burned contacts. In addition, Kirk key interlocks prohibit the opening of fuse compartment doors while switches are closed.

I-T-E Power Switching Centers are designed, of course, for both safety and economy. Unique I-T-E standardized cubicles and building block construction reduce engineering expense (the saving is passed on to you), and also shorten the time between order and delivery. Equipment arrives on the job in sturdy, preassembled units, ready for easy, fast installation. And new feeders can be added any time.

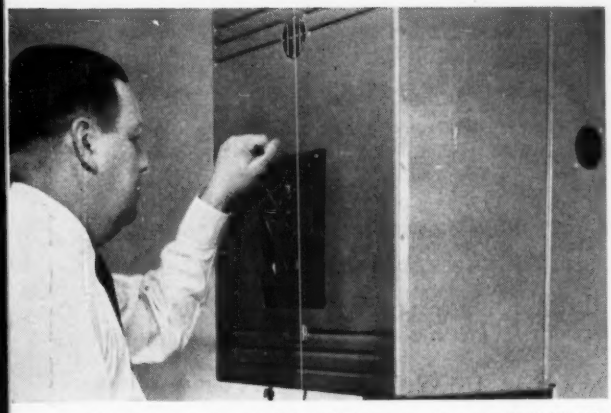
These extra advantages add up to greater value . . . because you pay no more for I-T-E electrical equipment. That's why it is preferred among so many companies that insist on greater value. Investigate I-T-E equipment next time you buy.



**First cost is your last cost.** I-T-E molded case circuit breakers not only give you vastly better protection than fused devices . . . but in most cases they actually cost you less in the long run. To restore power after a fault, all you do is flip a toggle handle. Nothing to replace. No lost time. And you're absolutely certain that you have correct protection. Choose the circuit breakers you need from the I-T-E line . . . broadest in the field. Wide variety of enclosures for both indoor and outdoor installations.



**Safety for conductors.** I-T-E nonsegregated phase bus, safely enclosed in metal, shrugs off the hazards of dust and weather and provides complete protection for plant personnel. Widely used for connecting transformers to switchgear and for distributing power in factories. Far easier to tap into than cable. High dielectric strength. Available in a variety of types for indoor and outdoor installations. Ratings up to 13.8 kv and 3000 amp. I-T-E nonsegregated phase bus is delivered factory fabricated for easy installation and sure fit.



**Individual circuit control.** Install these new URELITE individually enclosed circuit breakers right near heavy loads or as local control devices for main trunk lines up to 600 volts. Main disconnect contacts visible through side window for extra safety. Now available with I-T-E K-LINE circuit breakers . . . world's most advanced. Pulldown handle action provides quick manual make for safety and long contact life. New, wide-range overcurrent trip device lets you increase breaker setting when the load increases. No parts to replace.

**I-T-E Circuit Breaker Company** I-2
1900 Hamilton St., Philadelphia 30, Pa.

- ☐ Power switching centers
- ☐ Molded case circuit breakers
- ☐ Metal-enclosed bus
- ☐ URELITE circuit breakers
- ☐ Other_____
- ☐ Metal-clad switchgear (4.16 and 13.8 kv)
- ☐ Secondary unit substations
- ☐ TRANFO-UNITS
- ☐ CORDON® circuit breakers

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

**SEND COUPON OR WRITE**

Get complete, up-to-date information on I-T-E equipment.



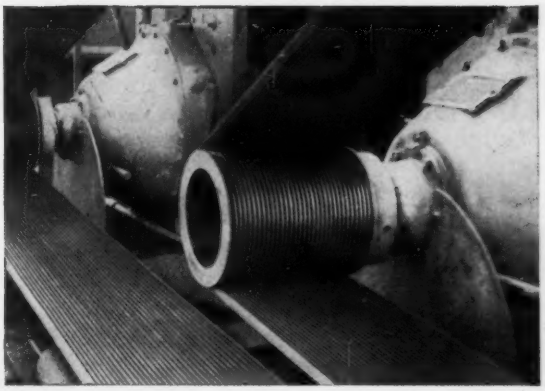
**For more facts circle 217 on Reader Service Card, p 117**

# WHY BUY ONLY 2/3 OF A CONVEYOR BELT?

## IT'S THE *LAST THIRD* OF R/M CONVEYOR BELT LIFE That Gives "MORE USE *for Your* DOLLAR"

The last one-third of conveyor belt life determines its final cost. And now, R/M's *new* construction concept assures you ⅓ longer life with Ray-Man Conveyor Belt! Every belt feature—troughability, resiliency, fastener holding ability, strength member fabric, cover thickness and toughness—all contribute to your conveyor belt life and cost. Therefore every Ray-Man component is now *precision proportioned* to assure a degree of belt balance never before possible. It adds up to ⅓ longer belt service life... *lower* costs for your coal handling operations.

Let an R/M representative show you how *extra* life in the last ⅓ of conveyor belt service means "More Use per Dollar" with Ray-Man Conveyor Belt and other R/M heavy duty constructions. Write for Conveyor Belt Catalog 25CB.



## R/M POLY-V® DRIVE

Patented new drive concept delivers up to 50% more power in same space as conventional multiple V-belt drives . . . or equal power in as little as ⅔ the space! Eliminates multiple V-belt "length matching" problems. Poly-V* assures more constant speed ratios, smoother running drive, longer drive life. Single unit belt permits narrower sheaves, less shaft overhang, less drive weight. Write for Bulletin #6638.

**Poly-V is a registered Raybestos-Manhattan trademark.*

---

## CONDOR V-BELTS

"The smoothest running V-belts made" for general service. Balanced construction and straight sidewall design assure *more* grip, *less* slip . . . *longer* trouble-free performance at *lower* cost. For shock loads under rugged drive conditions, R/M Super-Power V-Belts give up to 40% greater hp capacity compared to standard types. Write for Bulletins.

## RAY-MAN CONVEYOR BELT

**Trains Naturally**

**Holds Fasteners**

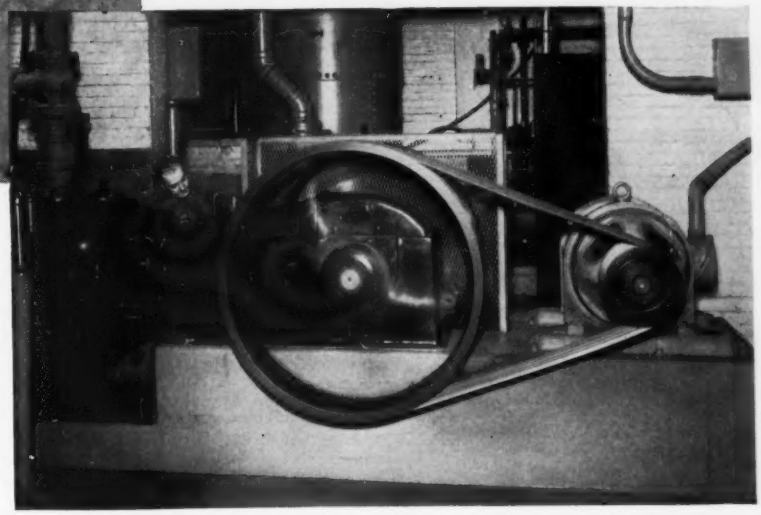
**Resists Impact and Ripping**

**Requires No Breaker Ply**

**Double Compensation Relieves Outer-Ply Stress**

**Exclusive "XDC" Long-Wear Cover**

**Moisture Resistant, Mildew-Proof**



RM-857

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

**MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY**

# RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls



For more facts circle 218 on Reader Service Card, p 117

Case Type No. 1279.

Case Type No. 1379 is Alumalife, while similar case Type No. 1079 is Cast Iron.

Case Type No. 1377.

# In such cases DURAGAUGES® naturally serve longer

You have a choice of three case materials—Alumalife®, a special aluminum alloy, Cast Iron, rugged and durable, Phenol, tough and rigid plastic—plus the unique "Maxisafe" design when you specify Ashcroft Duragauges.

All three case materials use a chrome plated, die-cast retaining ring to keep out harmful fumes and dirt. Case construction simplifies servicing—the entire system can be easily removed for recalibration or repair.

The "Maxisafe" case provides absolute protection to the viewer, easy and quick access to the tube and movement assembly. An integrally cast solid wall separates the dial from the tube and movement. A safety cover plate on the back is held in position by a knurled knob.

Regardless of your gauge case requirements, there's an Ashcroft Duraguage to do the job. Contact your local Ashcroft Gauge Distributor for complete facts.

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi.

**CASE MATERIALS, TYPE NUMBERS, MOUNTING AND SIZES**

| CASE | TYPE NO. | BACK FLANGE | MOUNTING | | CONNECTION | | DIAL SIZE |
|---|---|---|---|---|---|---|---|
| | | | WALL | FLUSH | LOWER | BACK | |
| Black Alumalife | 1379 | Yes | Yes | Yes | Yes | Yes | 4½", 6" |
| Black Cast Iron | 1079 | Yes | Yes | Yes | Yes | Yes | 4½", 6", 8½" 10", 12" |
| Black Phenol, Turret Design | 1279 | No | Yes | Yes* | Yes | Yes | 4½", 6", 8½" |
| Black Alumalife** | 1377 | No | No | Yes | No | Yes | 4½", 6", 8½" 10", 12" |

**May be flush mounted by using Flush Mounting Ring, Catalog No. 1278.*
***The 10" and 12" dial sizes are made in cast iron only.*

**ASHCROFT PRESSURE GAUGES**

*A product of*

**MANNING, MAXWELL & MOORE, INC.**

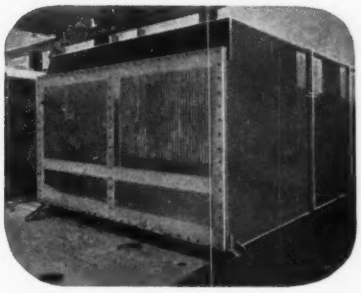
*Consolidated Ashcroft Hancock Division • Stratford, Connecticut*
*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



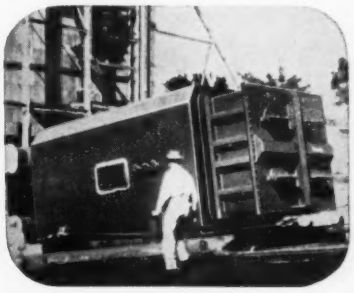
For more facts circle 219 on Reader Service Card, p 117

*and auxiliary equipment*

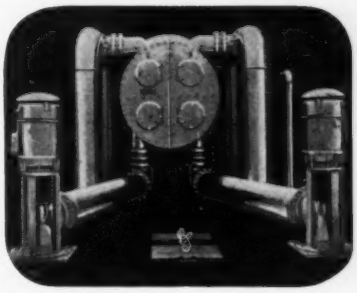
# HOW C.H. WHEELER CONDENSER DESIGN saves space...



**Head Room** problems are solved by compact condensers like this one. Turbine floor to basement floor, in this case, is only 20 ft. The Unit has 65,000 square feet of condensing surface.

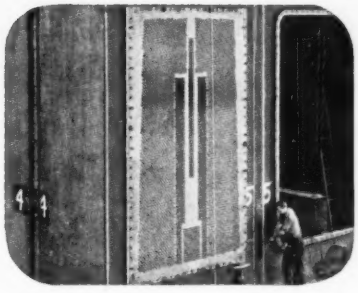


**Rectangular Cross Section** makes C.H. Wheeler Condensers adaptable to nearly any space or condenser arrangement because the length, width and height of any Wheeler Unit can be varied almost at will.

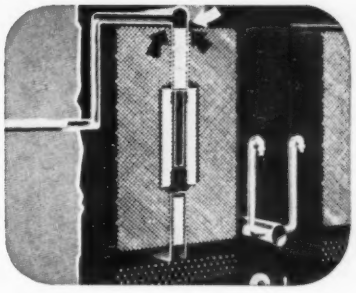


**But Wheeler Doesn't** limit itself to rectangular design. A round cross section worked out better here, for example, at the first planned gas-steam turbine station ever designed and built in United States.

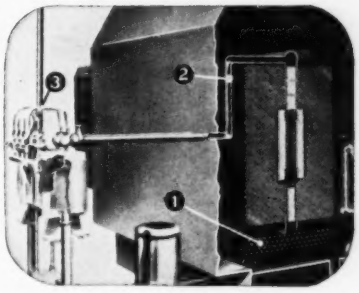
## improves power generating efficiencies...



**Triple Lane tube layout,** another design feature, provides 3 pathways for steam travel, utilizes maximum cooling surface and produces higher condenser vacuums for power generating stations.

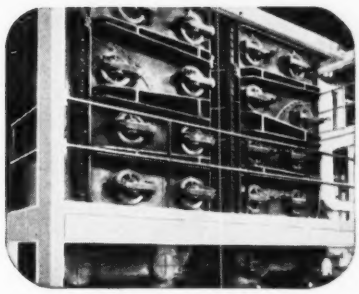


**Location of air-vapor takeoff** speeds steam travel and allows steam to penetrate to the peripheries of all tubes. It thus improves condenser efficiencies and overall power station operation as well.

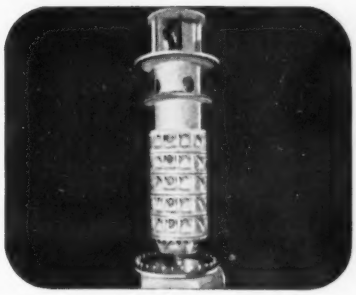



**Deaeration of condensate** not to exceed 0.01 cc. oxygen/liter is available with special Wheeler designs. Note the Deaerating Bars (1), the Air-Vapor Suction Line (2), and Tubejet® Ejectors (3).

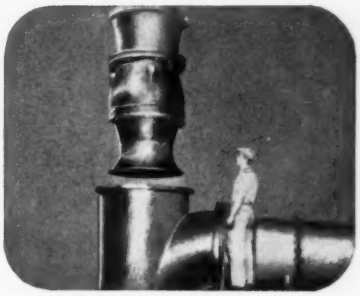
## and reduces maintenance



**Patented Reverse Flow** permits flushing tubes and sheets without shutting down Unit, during full load with either or both circulating pumps operating. No additional circulating water inlet or discharge piping necessary with C.H. Wheeler's Reverse Flow.



**"Pull-Out" Condensate Pumps** simplify maintenance because entire pumping element, including all rotating parts, can be removed without disturbing either the pump barrel or the piping connections.



**C. H. Wheeler Circulating Pumps,** like Condensate Pumps, are easy to inspect and maintain because of "Pull-Out" design. In addition, shafts are heat treated alloy steel and impellers are statically and dynamically balanced for trouble-free operation.

C. H. Wheeler has been designing and building condensers since 1903; has developed such features as Dual Bank Design and Reverse Flow.

# C. H. WHEELER MFG. CO.

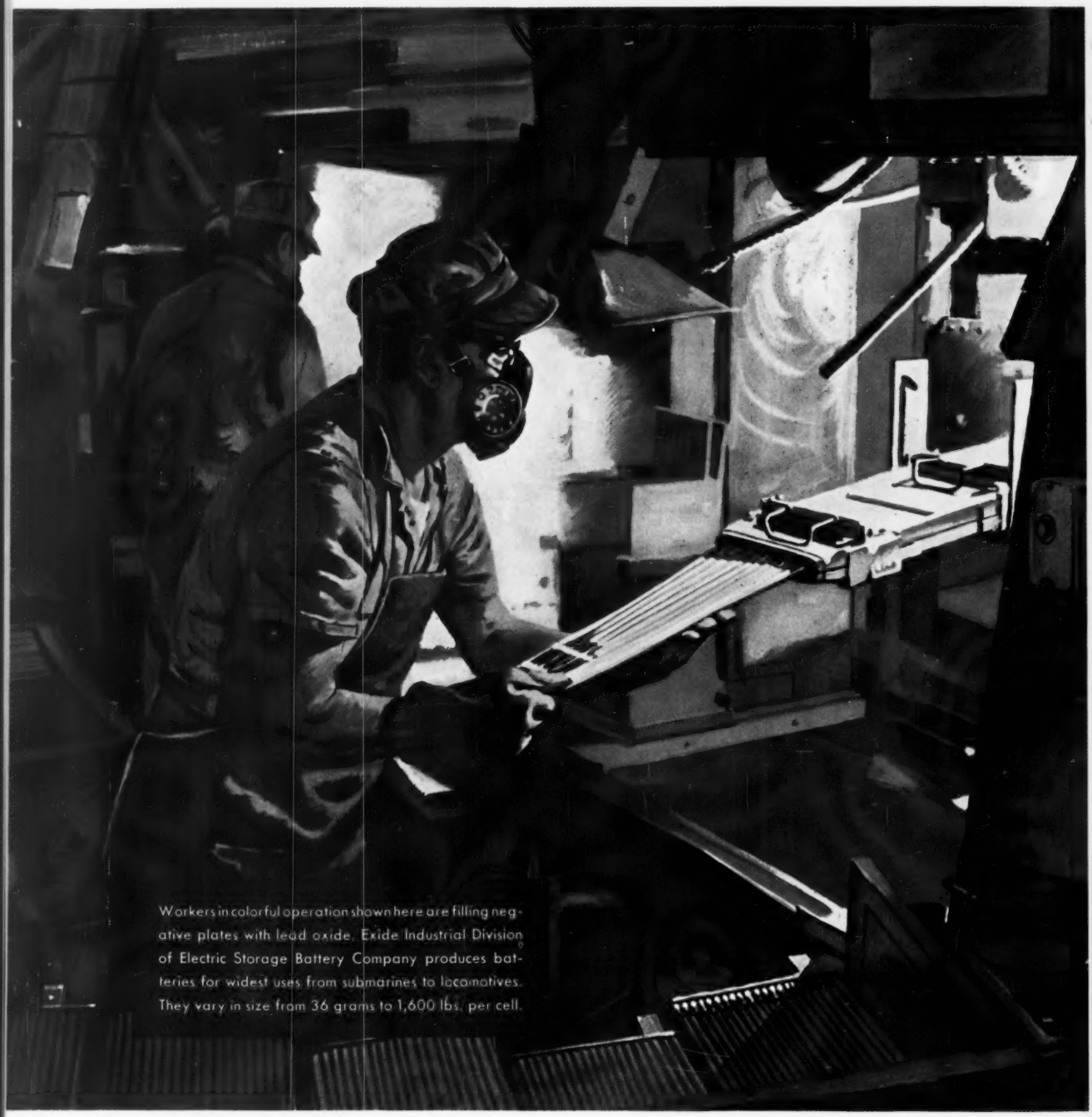
19TH & LEHIGH AVENUE
Philadelphia 32, Pennsylvania

*Whenever you see the name C. H. Wheeler on a product, you know it's a quality product*

**Steam Condensers • Steam Jet Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products**

*Correct Lubrication in Action...*

# Mobil "sparks" $48,380



Workers in colorful operation shown here are filling negative plates with lead oxide. Exide Industrial Division of Electric Storage Battery Company produces batteries for widest uses from submarines to locomotives. They vary in size from 36 grams to 1,600 lbs. per cell.

Mobil

**Complete Engineering Program**
**Proved Petroleum Products**

**Mobil**

SOCONY MOBIL OIL CO., INC., and Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP., MOBIL OVERSEAS OIL CO., INC.

# saving for Exide Battery

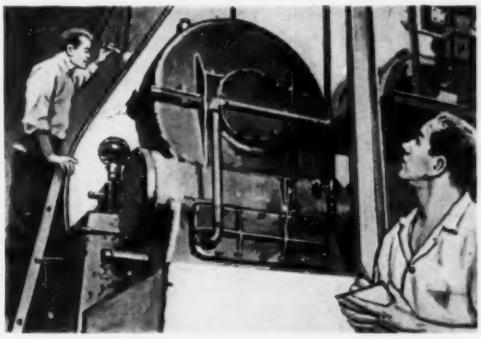
**Here's how Exide Industrial Division of The Electric Storage Battery Company turned up new ways to cut maintenance costs, with the help of Mobil**

"*How can we make it better, or more efficiently?*" That's The Electric Storage Battery Company's challenging attitude. For five years now Socony Mobil has helped meet this challenge in the company's Philadelphia plant. During this period Mobil's lubrication program has saved $48,380 in maintenance costs.

Mobil's Correct Lubrication program helped put the plant's lubrication on a sound engineering basis. Every machine's needs were charted . . . rigid maintenance schedules established. Even the oilermen's routes were revised to improve efficiency. As a result, 1,256 maintenance man-hours a year are now available for other purposes. Other sizable savings are listed below.

This is *Correct Lubrication in Action.* Lubrication specialists who work closely with plant supervisors. In-plant lubrication training for maintenance personnel. Research and laboratory facilities. These services and many more are all backed by Mobil's 93 years of lubrication experience. It's helped Exide Industrial Division produce top quality batteries for less cost. It can help you cut costs, too.

Repair of roller drive chains interrupted schedules of Grid Casting Units at five-month intervals. Mobil recommended installation of 4 gravity feed oilers with lubrication brushes that cut downtime, maintenance time, too. Saving—$8,003.



Inspection revealed abnormal wear of bull gear on grinding-mill and need for major overhaul and replacement. Mobil recommended grinding teeth, resetting gear and use of heavy, high-film strength gear oil. Gear replacement avoided—$10,000 saved.

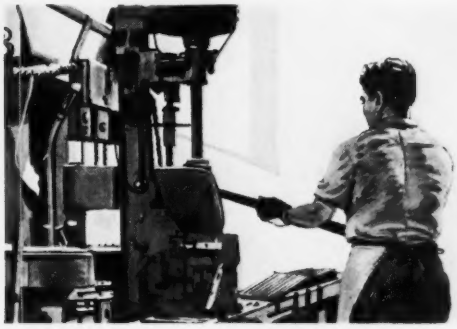
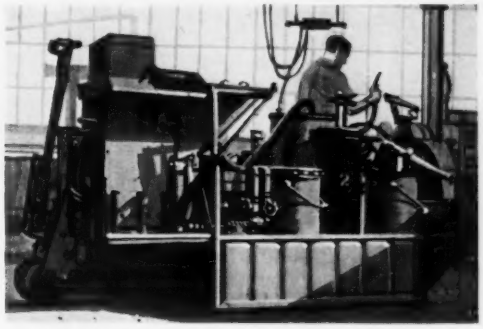


Plate Filling Machines were being greased by hand at thirty-minute intervals. Mobil recommended automatic grease system with water-resistant Mobil product. This saved 25 man-hours per week . . . cut bearing wear rate 25% . . . has already saved $15,300.

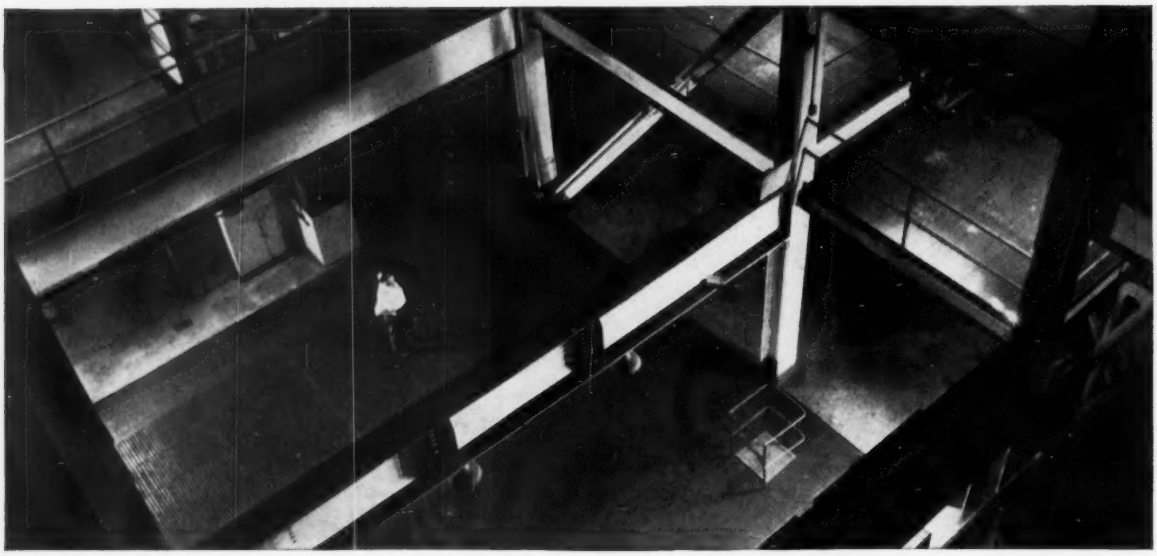


Modern lubricating equipment, efficient routing and charts prepared for every machine in Exide's plant by Mobil engineers reduced lubrication application time 68%. Types of lubricants were cut from 25 to 10, simplifying storage and inventory.

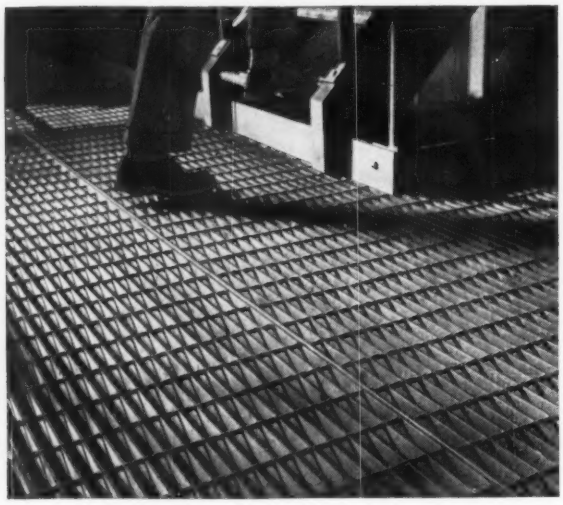
# Correct Lubrication

***Another reason You're Miles Ahead with Mobil!***

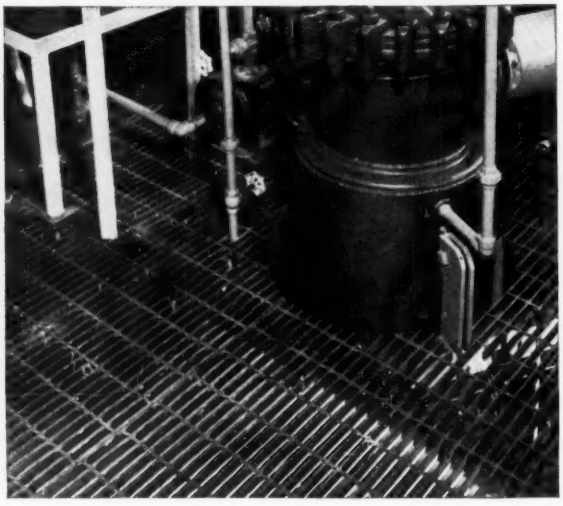
# *designed for flexibility*...**Electroforged® for strength**
# Blaw-Knox Grating fits modern plant needs



**More floor space** . . . Platforms, mezzanines and loading docks made of flexible Blaw-Knox Electroforged Steel Grating increase storage space, enlarge feeder areas. Easily installed, and easily adapted to changing layouts.



**Safer walking** . . . on *non-slip* floors, walkways and stairs, Blaw-Knox Electroforged Steel Grating provides rigid one-piece construction and features the twisted cross bar to make every step a safe step.



**Fits anywhere** . . . around pipes, beams and machinery to provide a neat, easy-to-maintain surface. There's nothing to wear, patch or catch dirt. And Blaw-Knox Grating admits more light and air for ideal working conditions.

*Write for Bulletin 2527 and see how Blaw-Knox Grating can be custom fabricated to meet your plant improvement specifications.*

BLAW-KNOX

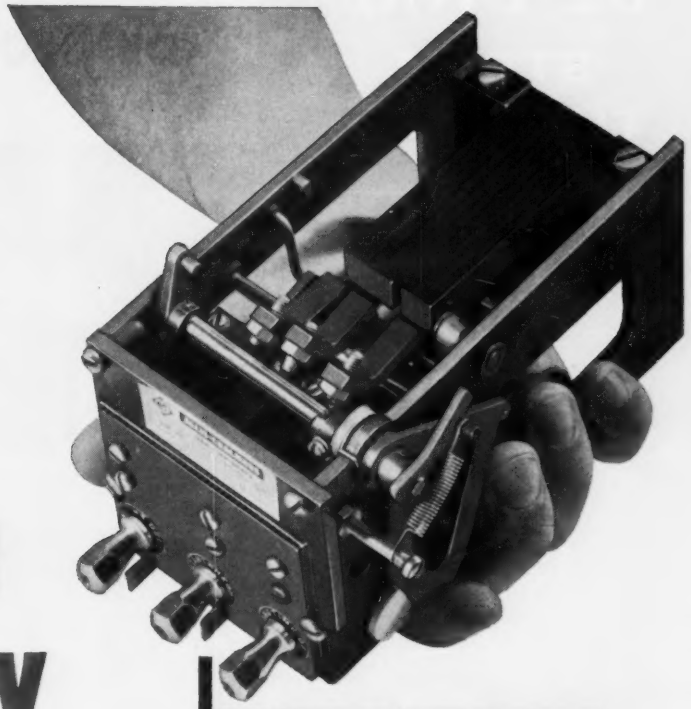
## BLAW-KNOX COMPANY

*Equipment Division*
*Department Y, Pittsburgh 38, Pennsylvania*




For more facts circle 222 on Reader Service Card, p 117

**ALLIS-CHALMERS**
**low voltage**
**switchgear**



## Here's

# Proven Accuracy

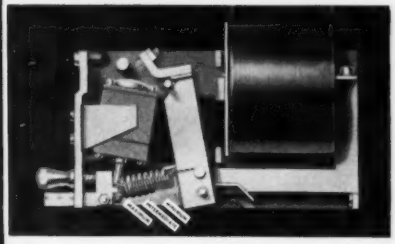
## 3 independent elements available in series trip device

This time-proven feature of Allis-Chalmers low voltage switchgear provides:

- **Accurate settings** — Adjusting knobs with calibration scales on front of trip device permit operator to adjust elements independently and set pickup for long time (80-160%), short time (500-1000%), and instantaneous (500-1500%).
- **Accurate action** — Silicone oil-filled, positive displacement time-delay device is completely calibrated and sealed under vacuum.
- **Accurate adjustment** — Minimum, maximum and intermediate time-delay band settings are field adjustable for each pickup value for fine selectivity.
- **Accurate indication** — Overcurrent trip flag to indicate phase which caused tripping of breaker is available.

Each trip element has its own armature and each armature acts directly on trip block. Accurate trip device is only one feature of Allis-Chalmers low voltage switchgear. For complete details, call an A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

Operator inserting circuit breaker using positive-position pantograph. Note trip device accessibility, dead-front breaker, and drawout interlock.



Cutaway shows arrangement of components in Allis-Chalmers direct-acting series trip device. Note calibration scale below adjusting knobs and time band setting on armature extension.

A-C ALLIS-CHALMERS

A-5553

**ALLIS-CHALMERS**



For more facts circle 223 on Reader Service Card, p 117

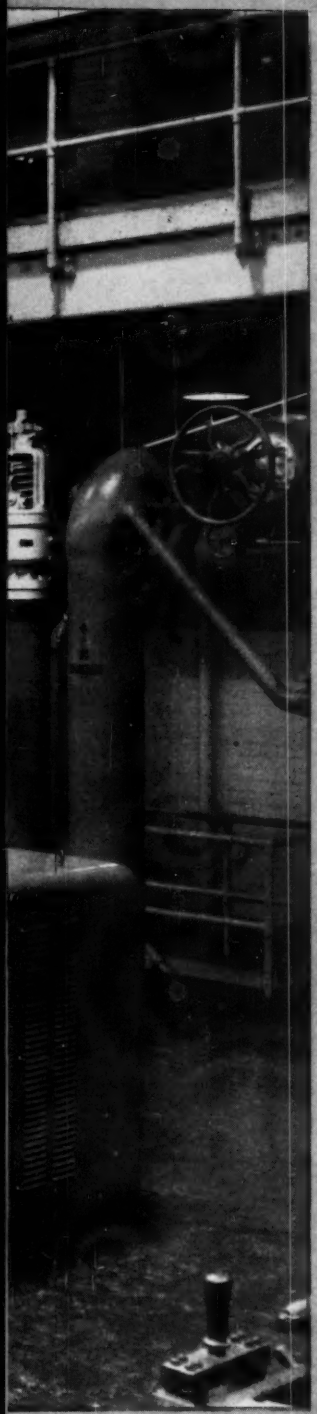
# DE LAVAL STEAM TURBINES

## for process industries

The photograph above shows a De Laval direct-connected turbine generator installation at Parke, Davis & Co., Detroit, Michigan.

This controlled extraction, controlled back-pressure unit supplies 5000 kw using process steam. Extraction is at 130 psig, exhaust is 5 psig. This new machine was added to already existing De Laval units that have been in service for 30 years. In addition, the Parke-Davis Research Laboratories in Ann Arbor, Michigan will soon be using a new 1000 kw unit.

D[illegible]



# Parke, Davis & Co. uses DE LAVAL Steam Turbines for process and power generation

**Proved economy, dependable service**

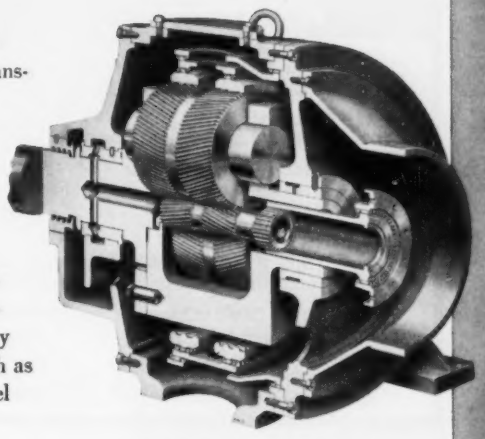
In many process industries, an important by-product is economical electric power. If appreciable quantities of process steam are used, power generation can be achieved at comparatively low cost.

De Laval, pioneer in high speed rotating machinery, has continued to maintain engineering and manufacturing leadership. If you have process application where low-cost power generation can be utilized, call on De Laval.

## De Laval-Stoeckicht Planetary Gears

In many applications where high speed and high horsepower are transmitted, the De Laval-Stoeckicht planetary gear can be used to great advantage. It is also used as a speed increaser or decreaser in many industrial installations.

Among its outstanding characteristics are light weight, in-line construction and space saving. It may be used for all kinds of drives such as gas turbines, steam turbines, diesel engines, etc.



**Write for Bulletin 2400**

DE LAVAL *Steam Turbine Company*

815 NOTTINGHAM WAY, TRENTON 2, N. J.

# IT STICKS TO HOT OR COLD SURFACES!

# EAGLE-PICHER

# SUPER "66"

## INSULATING CEMENT

SPOTTING! TROWELLING! FINISHING!

- Because it sticks, Super "66" saves time—applies quickly to any equipment, cold or hot! Effective up to 1800 F.
- Because it sticks, Super "66" saves money—provides far greater coverage and more efficient insulation.
- Because it sticks, Super "66" makes difficult jobs easy—can be used on irregular shapes where application of other insulations is often impossible. Usually requires no reinforcing on applications up to 1½ inches thick.
- Unique "springy ball" structure of small, resilient mineral wool pellets results in maximum efficiency—maximum fuel savings!
- Super "66" contains a special rust inhibitive which actually prevents corrosion!

*Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.*

**FREE SAMPLE!**

**Write today!**

Eagle-Picher Super "66" Insulating Cement conforms to Commercial Standard CS-117-49.

*Since 1843*

EAGLE EP PICHER

## EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(*Member of Industrial Mineral Fiber Institute*)



For more facts circle 225 on Reader Service Card, p 117

For more facts circle 226 on Reader Service Card, p 117 ➤

U.S.S. Skipjack slides down the ways at General Dynamics' Groton, Connecticut, yard to join sister ships Nautilus and Seawolf. Garlock Spool-Type Rubber Expansion Joints (below) prevent noise and vibration in Skipjack's water and condensate lines.



# NOW 3 ATOMIC SUBS STOP NOISE AND VIBRATION WITH GARLOCK RUBBER EXPANSION JOINTS

Aboard the U.S.S. Nautilus, Seawolf, and Skipjack, Garlock All-Rubber Expansion Joints prevent noise and vibration in water and condensate lines . . . help maintain smooth and silent service on atomic subs.

Garlock All-Rubber Expansion Joints react to the slightest pressure; this relieves any stress on expensive piping. Moreover, they are reinforced with steel rings, thus assuring greater strength. They are recommended for use against water, oil, mild acids, gases, and exhaust steam. Garlock has Rubber Expansion Joints ¾" to 72" in dia.; in round, rectangular, tapered, and offset spool types or U types.

Rubber Expansion Joints are another important part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. Ask your Garlock representative for his recommendations, or write for Folder AD-137.

**THE GARLOCK PACKING COMPANY, Palmyra, N.Y.**

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada.

GARLOCK

*Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products*

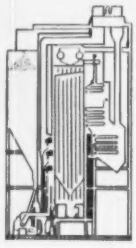
Canadian Division: The Garlock Packing Co. of Canada Ltd.

Plastics Division: United States Gasket Company

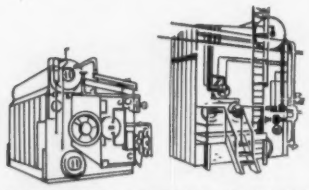
**Power Plant Products**

**HEAT ENGINEERED BY FW**

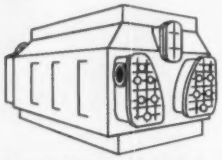
**LARGE STEAM GENERATORS**



Designed to meet all requirements for Central Station or Industrial power plants, in single- or twin-furnace designs, with or without reheat or dual circulation.

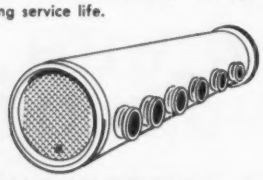


**PACKAGED and FIELD-ERECTED BOILERS**—Compact, economical, standardized units in capacities from 10,000 to 450,000 lb/hr, oil, gas or pulverized coal fired.

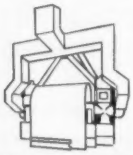


**CONDENSERS and HEATERS**—Condensers of single or two-pass, double or counter-flow designs. All-welded high and low pressure feed-water heaters.

**COOLING TOWERS**—Induced draft counter flow towers of all-redwood construction for maximum dependability and long service life.



**NUCLEAR COMPONENTS**—Heat exchangers, steam generators, pressurizers, reactor vessels, separately-fired superheaters for stationary and marine power plants.



**PULVERIZED FUEL SYSTEMS**—Completely engineered systems utilizing FW ball mill or MB planetary roll and table pulverizers.

# HEAT ENGINEERING

# WORLD'S FIRST

# NATURAL CIRCULATION

*321,500 kw Unit No. 3 at Detroit Edison's River Rouge Power Plant is served by a Foster Wheeler Reheat Steam Generator —one of the most efficient ever built*

One of the largest steam generators ever built, this unit was heat engineered by Foster Wheeler to meet the most exacting plant requirements. It supplies Detroit Edison's River Rouge Unit #3 with *two million* pounds of steam per hour at 2450 psi and 1050 F at the superheater outlet. The steam is reheated to 1000 F after it has passed through the initial stages of the turbine.

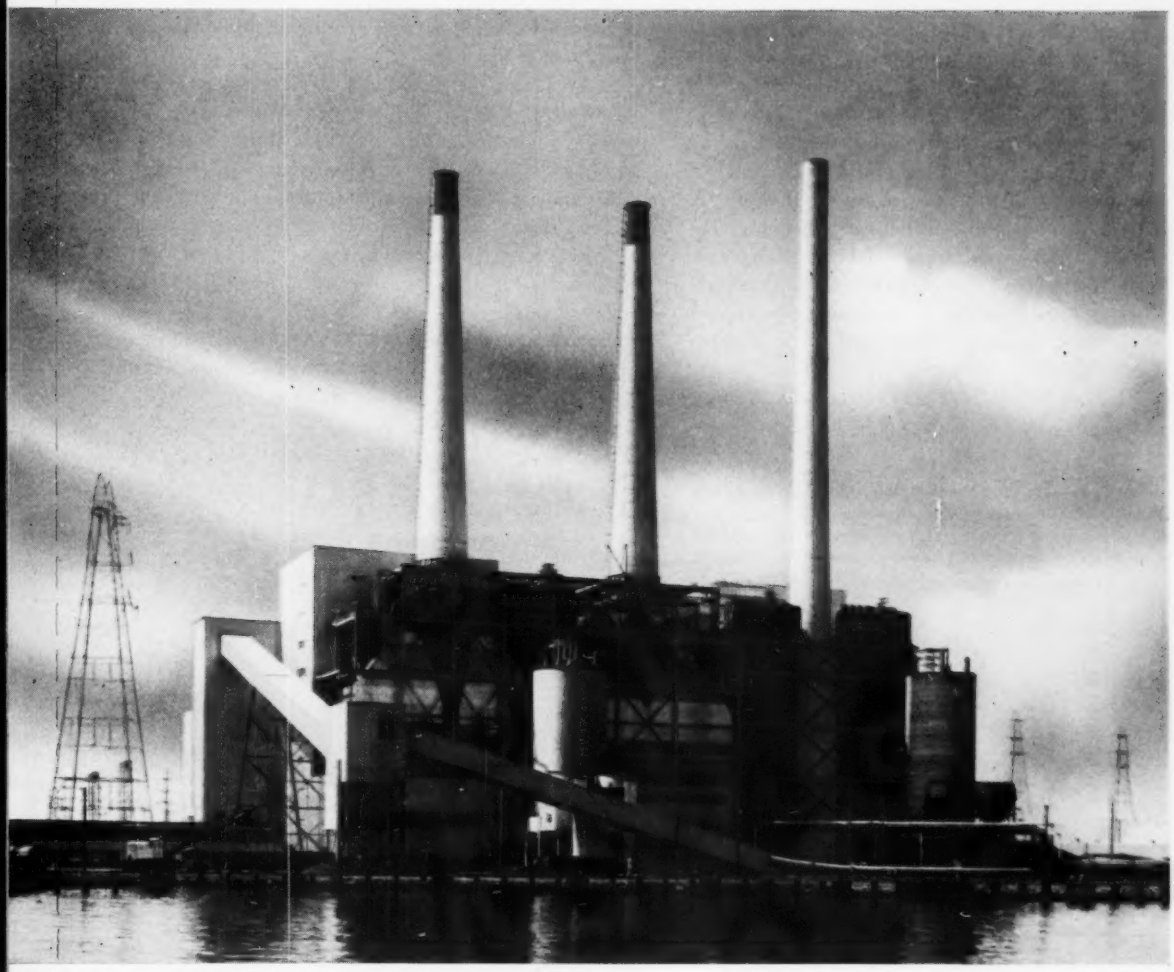
Size alone is not the only measure of this installation. The FW steam generator also helps make Unit #3, with a heat rate of 8685 Btu per kwhr, one of the most economical and efficient ever built, producing a kilowatt hour of electricity from less than ¾ lb of coal.

With more than a half century of specialized experience in heat engineering and steam generation, Foster Wheeler will welcome the opportunity to quote on your steam plant units—for any pressure or any capacity. Foster Wheeler Corporation, 666 Fifth Ave., New York 19, N.Y.

by Foster Wheeler creates

# 2,000,000 lb/hr

# STEAM GENERATOR



## FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.



For more facts circle 227 on Reader Service Card, p 117

*the man on the inside knows...*

# Republic ELECTRUNITE Boiler Tubing offers Quality he can see and feel

Quality is the key to trouble-free service. The man on the job, the man inside the steam drum, knows Republic ELECTRUNITE® Boiler Tube quality.

As a skilled craftsman, his authority is his *feel* of the tool. He can tell by the ductility of the tube . . . the easy, uniform flow of metal into the drum-hole grooves in the rolling-in operation.

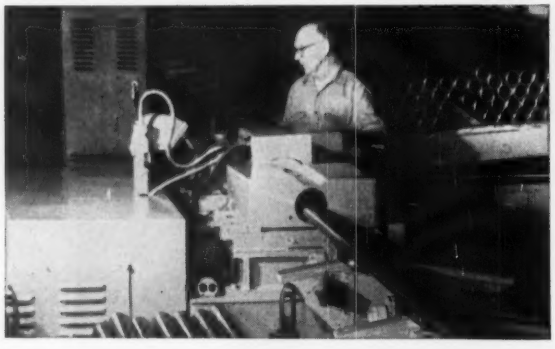
The man on the inside felt this at the job site of The Gardner Division, Diamond Gardner Corporation, Lockland, Ohio. The job was designed, fabricated, and installed by Riley Stoker Corporation, Worcester, Massachusetts. The unit has a designed capacity of 100,000 pounds of steam per hour, 700 psi, at a steam temperature of 720° F.

*Quality is built-in.* Republic ELECTRUNITE Boiler Tubing is made of highest quality flat-rolled, open-hearth steel produced in Republic's own mills, carefully controlled every step of the way.

Every length of ELECTRUNITE is hydrostatically or electronically tested to conform with the applicable ASTM specifications and the ASME Boiler and Pressure Vessel Code, as well as local, state, and boiler insurance requirements. The stress values for Republic ELECTRUNITE Tubes are the same as those for tubes made by other processes for temperatures up to 850° F. And ELECTRUNITE is available for pressures over 2000 psi in various sizes and wall thicknesses.

For complete Republic ELECTRUNITE Boiler, Condenser, or Heat Exchanger Tubing facts, call your Republic representative. Or, send coupon today.

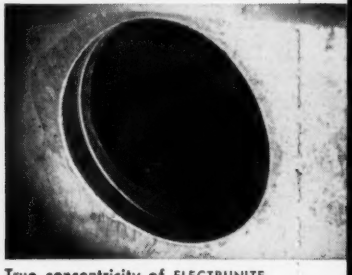
**QUALITY YOU CAN MEASURE—FARROWTEST®!** Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects defects of critical size. FARROWEST is offered as an alternative to other less positive tests in accordance with table below, at no extra cost.



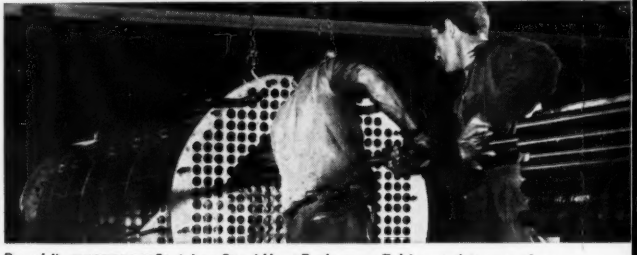
| Wall Thickness (B.W. Gage) | Minor Dimension of Defect (Length or Depth) | Defective Area (Length X Depth Plane) |
|---|---|---|
| 20 | 0.0006 IN. | 0.0025 Square Inches |
| 18 | 0.006 IN. | 0.003 Square Inches |
| 16 | 12.5% of Wall | 0.003 Square Inches |
| 14 and 13 | 12.5% of Wall | 0.004 Square Inches |
| 12 and Heavier | 12.5% of Wall | 0.005 Square Inches |

**FARROWTEST** detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to, or greater than, shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

Full normalizing makes ELECTRUNITE Boiler Tubing uniformly ductile for smooth, easy bending, trouble-free service. Quality is built-in.



True concentricity of ELECTRUNITE assures fit-right installations at the header-hole for easier roller expanding. Write for information.



Republic ELECTRUNITE Stainless Steel Heat Exchanger Tubing resists corrosion and provides long trouble-free service for main surface condensers in utility power plants where water is a problem. Write for additional facts.

# REPUBLIC STEEL

*World's Widest Range of Standard Steels and Steel Products*

**REPUBLIC STEEL CORPORATION**
**STEEL AND TUBES DIVISION**
**DEPT. C-6965**
**221 EAST 131st STREET • CLEVELAND 8, OHIO**

Please send more information on the following products:

☐ Republic ELECTRUNITE Boiler Tubes
☐ Republic ELECTRUNITE Heat Exchanger Tubes
☐ Carbon ☐ Stainless ☐ FARROWTEST Brochure

Name_____ Title_____

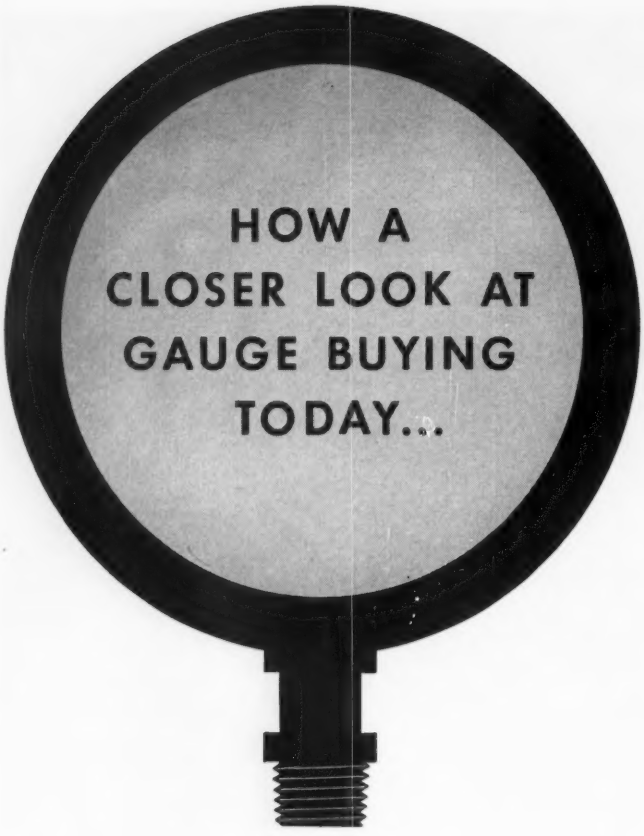
Firm_____

Address_____

City_____ Zone____ State_____



For more facts circle 228 on Reader Service Card, p 117



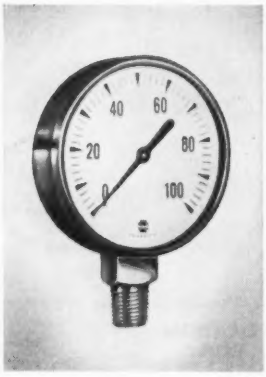

## can give you a tighter grip on gauge costs!

Been looking at gauge buying in your plant as "routine"? In terms of gauge performance you need, accuracy you get, price you pay . . . and how and where you buy? You can pick up real savings with a closer look at your gauge requirements . . . and at what United States Gauge offers. USG features the world's largest stock of indicating dial pressure gauges. Over 50,000 standards, plus specials, with all possible choices of sizes, case stylings, pressure ranges and case materials . . . up to and including the finest gauges of highest accuracy. One source meets 99% of your pressure gauge needs, with the exact gauge for the exact purpose at the right price. And one phone call to your USG distributor taps that source. See the Yellow Pages, or write for catalogs and name of your nearest USG distributor today.

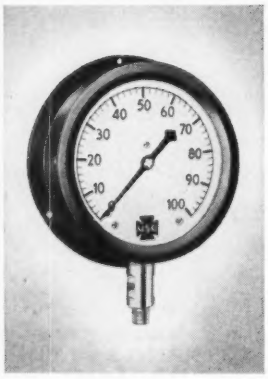
**UNITED STATES GAUGE**

Division of American Machine and Metals, Inc., Sellersville, Pa.

Find Your Nearest Distributor in The 'Yellow Pages'



**Replacement costs too high?** Volume - priced, precision - built USG drawn-case gauges are the money-savers for replacement of any A.S.A. Grade B gauge in your plant (accuracy of 2% guaranteed). These standbys are specified by more than 60% of original equipment manufacturers today. Proof of USG reliability and value! *Write for Catalog 64A.*



**Paying a premium for quality design, reliability?** Check the new USG A-Line, premium design at savings up to 40% of premium prices! Meets A.S.A. Grade A Standards, including accuracy of 1%. Wide range of cases, sizes, movements, pressures cuts *you* in on A-Line savings wherever you need dependable gauge performance. *Write for Catalog 305.*

**Paying for performance you don't get?** Look at the USG Supergauge® line. Built like a watch to A.S.A. specifications for Grade AA Test Gauges, these gauges pay for themselves in long-lived, dependable performance and lower maintenance costs. Accurate to 0.5% of scale range. Full selection of case styles, sizes and options. *Write for Catalog 1819.*

**Losing out on highest accuracy?** USG Test Gauges are the elite of the industry, equalling or exceeding A.S.A. Grade AA standards with accuracy as high as 0.2 of 1%! Styles, sizes and case materials for all types of laboratory and test uses. You can't buy higher quality and precision in a test gauge! Get your money's worth at USG. *Write for Catalog 400.*



For more facts circle 229 on Reader Service Card, p 117

*Industry*
NEEDS DEPENDABLE
NOURISHMENT *too!*

Take a tip from your family's dependence on "nature's most nearly perfect food". Coal is nature's most nearly perfect fuel. It's here in abundance for ages to come, a dependably low-cost and most efficient source of "go power"! It's convenient too —right on *Industry's* doorstep.

B&O

BITUMINOUS COALS FOR EVERY PURPOSE

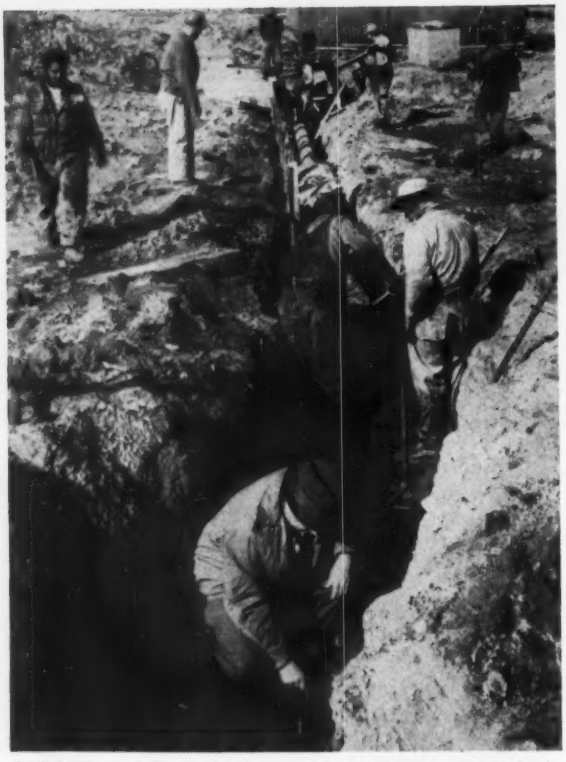
*Ask our man!* BALTIMORE & OHIO RAILROAD, BALTIMORE 1, MD., Phone: LExington 9-0400




For more facts circle 230 on Reader Service Card, p 117

The Esso Research Center's 3-story, 600-ft.-long office building includes conference rooms, technical library, correlations and computor center, medical department, cafeteria and landscaped court for its 800 employees. The project was designed and engineered by Voorhees Walker Smith Smith and Haines of New York City. Frank Briscoe, Inc., Newark N. J., is general contractor. August Arace & Son, Inc., Elizabeth, N. J., is mechanical contractor for heating and air conditioning. Alward Construction Co., Bernardsville, N. J., is doing the insulation work.

# Esso Research Center uses GILSULATE® for insulating mile of underground steam pipes

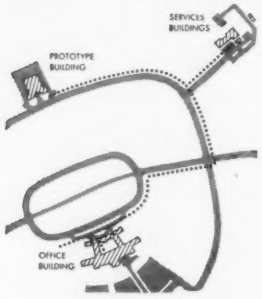


GILSULATE goes in fast. In the foreground the field inspector checks depth of pour. Directly in back of him, two workmen are shovelpointing and tamping. Other workers are sliding GILSULATE bags into pipe trench while men at rear are placing plywood forms near manhole.

Esso Research and Engineering Company, the scientific and engineering affiliate of Standard Oil Company of New Jersey, is now constructing a modern research center in Florham Park, N. J. To preserve the natural beauty of the 675-acre site, all heating, air conditioning, power and communications lines are run underground.

Steam, at a pressure of 250 lbs. (406°F.), will flow through a 600-ft.-long, 12" welded steel pipe from the boiler room to a manhole where a 1400-ft. string of 10", 8" and 6" pipe will carry heat to the prototype building. Similar piping leaves the other side of the first manhole and runs 2500 feet to the main office building. Trenches also carry 3" to 6" condensate return lines. The system has 24 expansion loops and seven manholes, and includes capped lines for use when facilities are expanded.

Over 500 tons of GILSULATE will be used for insulating and protecting the underground steam pipes. In addition to its low thermal conductivity, GILSULATE resists attack by acids, alkalies and electrical conductivity and provides excellent protection against corrosion. For full information on this low-cost, poured-in-place insulation, see your local GILSULATE distributor, or write our Salt Lake City office.




## FACTS ABOUT GILSULATE

1. **EASY TO USE**—just pour, shovelpoint and tamp... pipe heat does the rest.
2. **FORMS 3 ZONES** of protection against heat loss and all hazards commonly encountered by buried hot pipes.
3. **NEEDS NO HOUSING OR MECHANICAL SHEATHS:** no mixing, special handling or equipment.
4. **ONLY NEEDS NORMAL PIPE SPACING:** for multiple pipe or cramped conditions.
5. **THREE TYPES AVAILABLE:**
   Type A for 220-300° F. temp. range
   Type B for 300-385° F. temp. range
   Type C for 385-520° F. temp. range

THE TRIPLE-ZONE INSULATION FOR LIFETIME PROTECTION OF UNDERGROUND HOT PIPES

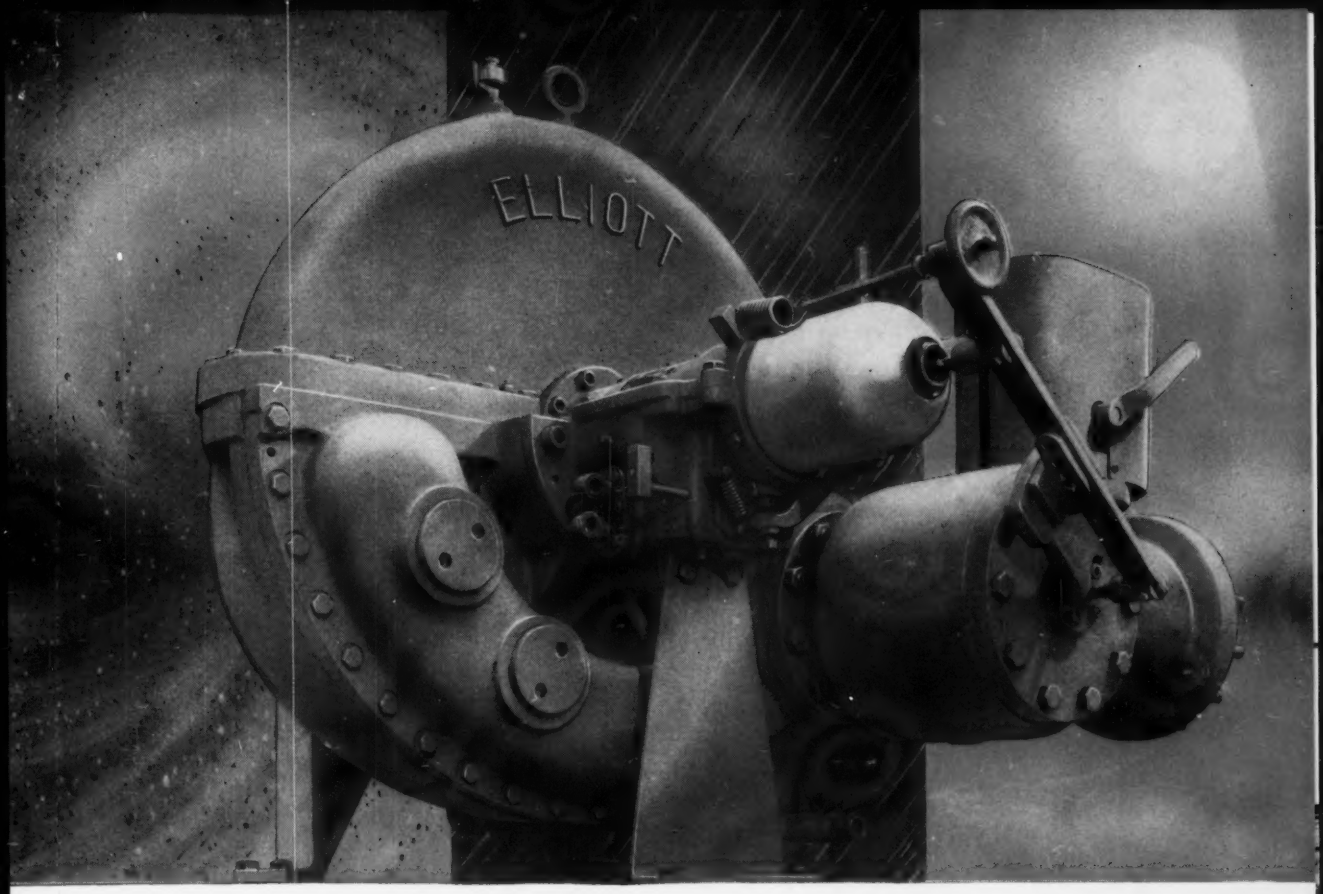
GILSULATE®

**AMERICAN GILSONITE COMPANY**

Affiliate of Barber Oil Corp. & Standard Oil Co. of California
Offices at: Municipal Airport P.O. Box 15, Salt Lake City, Utah
3537 Lee Road, Cleveland 20, Ohio
Distributors in Principal Countries of the World

*Do you receive Pipe Insulation News? Ask to be put on our mailing list.*


For more facts circle 231 on Reader Service Card, p 117
For more facts circle 232 on Reader Service Card, p 117 ➤

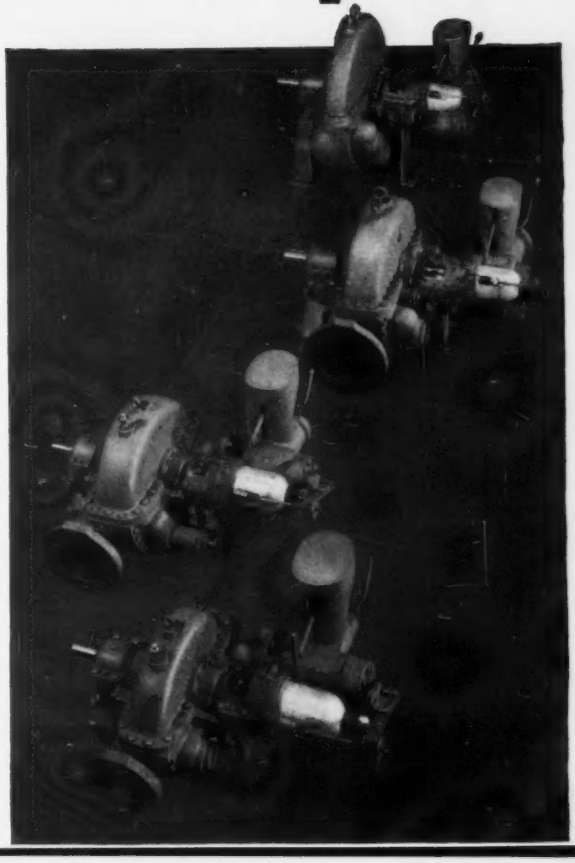



# rugged and weatherproof

## ELLIOTT YR TURBINES

Desert heat, arctic cold, driving rain and swirling dust don't faze rugged, dependable Elliott YR Turbines. Tightly sealed against dust, fumes and moisture . . . built strong and husky . . . these machines make dependable, economical drives for pumps, compressors, fans, line shafts, generators and other equipment.

The governor is simple and reliable, and is available in several modifications to match speed and pressure control requirements. YR turbines are designed for easy installation and service. Many key parts are interchangeable for various frame sizes. Four sizes are shown at the right. Write for descriptive bulletin H22-C.

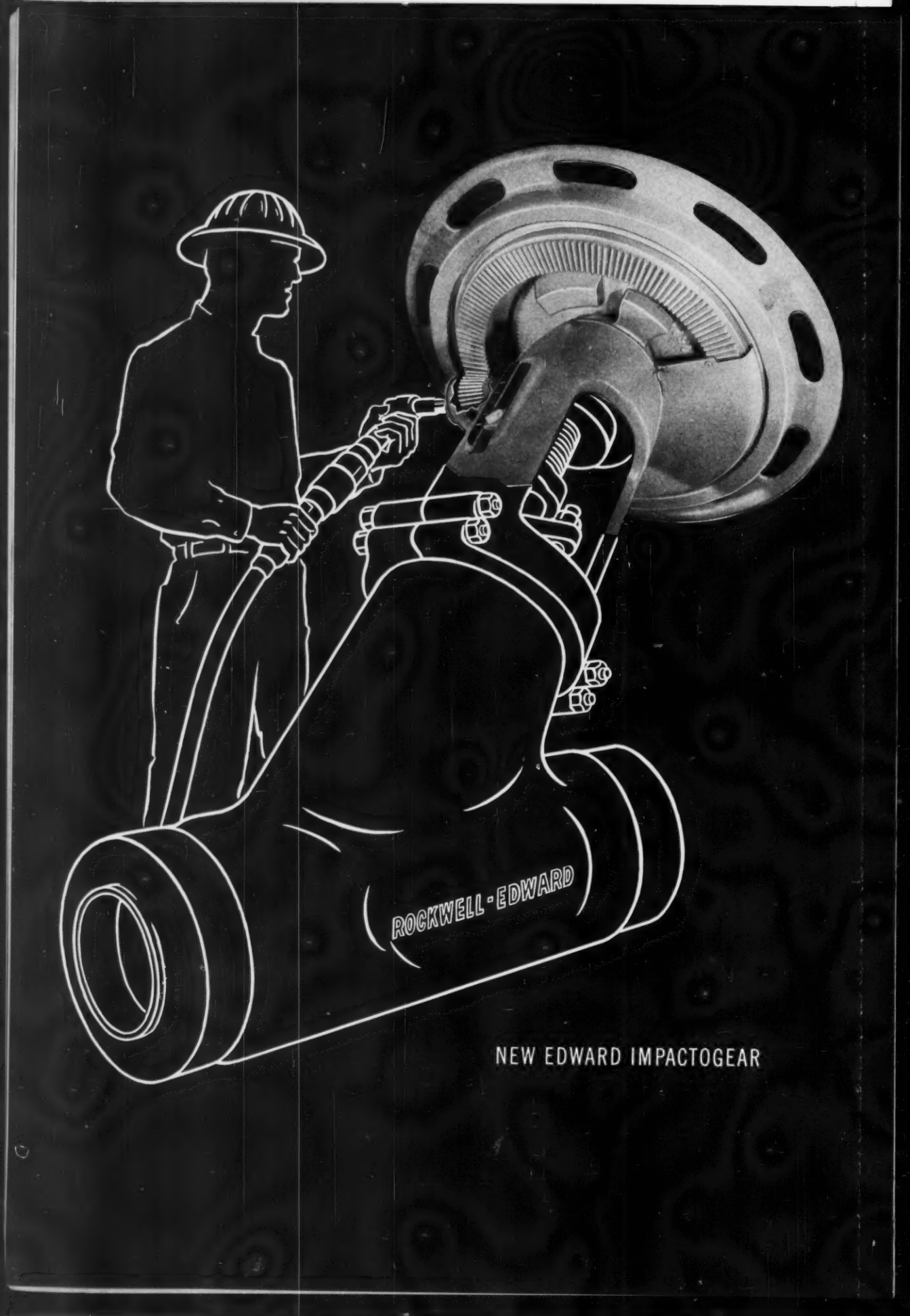


**In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators through 44 mw.**

TURBINES FOR DEPENDABLE day-in/day-out SERVICE

**ELLIOTT Company**

JEANNETTE, PENNSYLVANIA H9-2




NEW EDWARD IMPACTOGEAR

*What's New from Edward Valves*

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

# How Impactogear* operates high-pressure valves

You no longer need a crew of men to open or close big, high-pressure valves. New Edward Rockwell-built Impactogear makes big-valve operation a quick and easy job.

### FAST AND EASY "RUNDOWN"

Your operator simply applies portable air or electric wrench to pinion shaft-end of Impactogear. When power is applied, pinion turns ring gear, which turns handwheel and moves the stem to "closed" position. Impactor* handwheel then gives final tight shut-off with unique "hammer-blow" action. (Tests show it delivers 12 times the closing force of ordinary handwheels—with less effort!) Impactogear works quickly, can operate a 2500-lb 10" valve (for example) in only 2½ minutes. And Impactogear can be fitted to any 8" or larger Edward valve of 900-lb (or higher) pressure class.

### IMPACTOGEAR WITH AIR WRENCH

Impactogear utilizes standard portable air or electric wrenches generally available throughout industry. Example below shows how two typical air wrench ratings can be applied:

**Wrench Type No. 1—Stall torque 170 ft-lbs: Free speed 225 rpm; Weight 12 lbs**

For 12" and 14" 2500 lb. valves, operating pressures to 3500 psi

For 10" 2500 lb valves, all allowable operating pressures

For 10", 12" and 14" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures

**Wrench Type No. 2—Stall torque 200 ft-lbs: Free speed 300 rpm; Weight 38 lbs**

For 12" and 14" 2500 lb valves, operating pressures 3500 psi to 4500 psi

### IMPACTOGEAR WITH ELECTRIC WRENCH

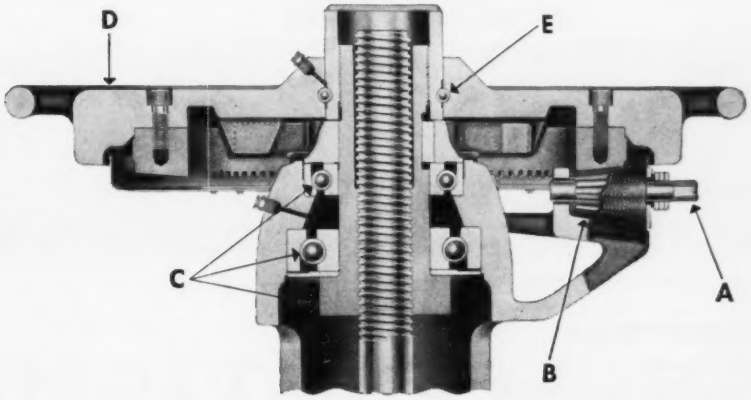
Portable electric wrenches are equally practical. Example below shows a typical electric wrench rating as applied to Impactogear:

**Wrench Type No. 1—Stall torque 176 ft-lbs: Free speed 225 rpm; Weight 44 lbs**

For 10" 2500 lb valves, all allowable operating pressures

For 10" and 12" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures

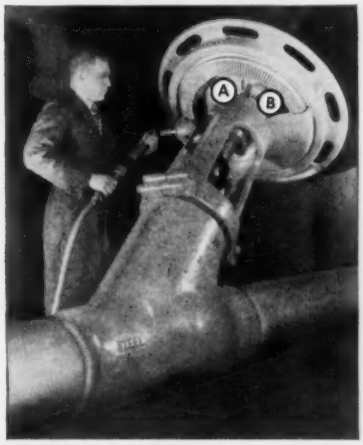



**Details of new Impactogear and Impactor Handwheel:**

A—Hex head of pinion gear shaft. Power wrench is applied here. B—12-to-1 bevel gear ratio is typical for median size handwheel. C—Exclusive EValthrust yoke bushing combines radial and thrust bearings for easy operation and long life. D—New Impactor handwheel concentrates mass near outer circumference for maximum impacting efficiency. E—New extra bearing increases operating efficiency.

### SLASH COST OF VALVE OPERATION

Individually installed operating motors are a big investment. They can add as much as 100% to the basic valve cost. *But now you can save that money by standardizing on Impactogear*—radically simple, thoroughly dependable mechanism utilizing *existing* compressed air or electric facilities. Your Edward Representative will be glad to provide full details and help you determine how Impactogear can work to your best advantage. Contact him—or write *Edward Valves, Inc., 1230 W. 145th Street, East Chicago, Indiana.* (Subsidiary of Rockwell Manufacturing Company). Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.




**LIGHTWEIGHT PORTABLE WRENCH** can operate as many Impactogear-equipped valves as desired. Or, each valve can be fitted with its own wrench. Either way, you get lower operating costs. Final closing is effected by handwheel lugs (A) striking hammer blows against cross arm keyed to yoke bushing (B). Half of gear cover was removed for illustration purposes.

*T.M. Reg. U.S. Pat. Off.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

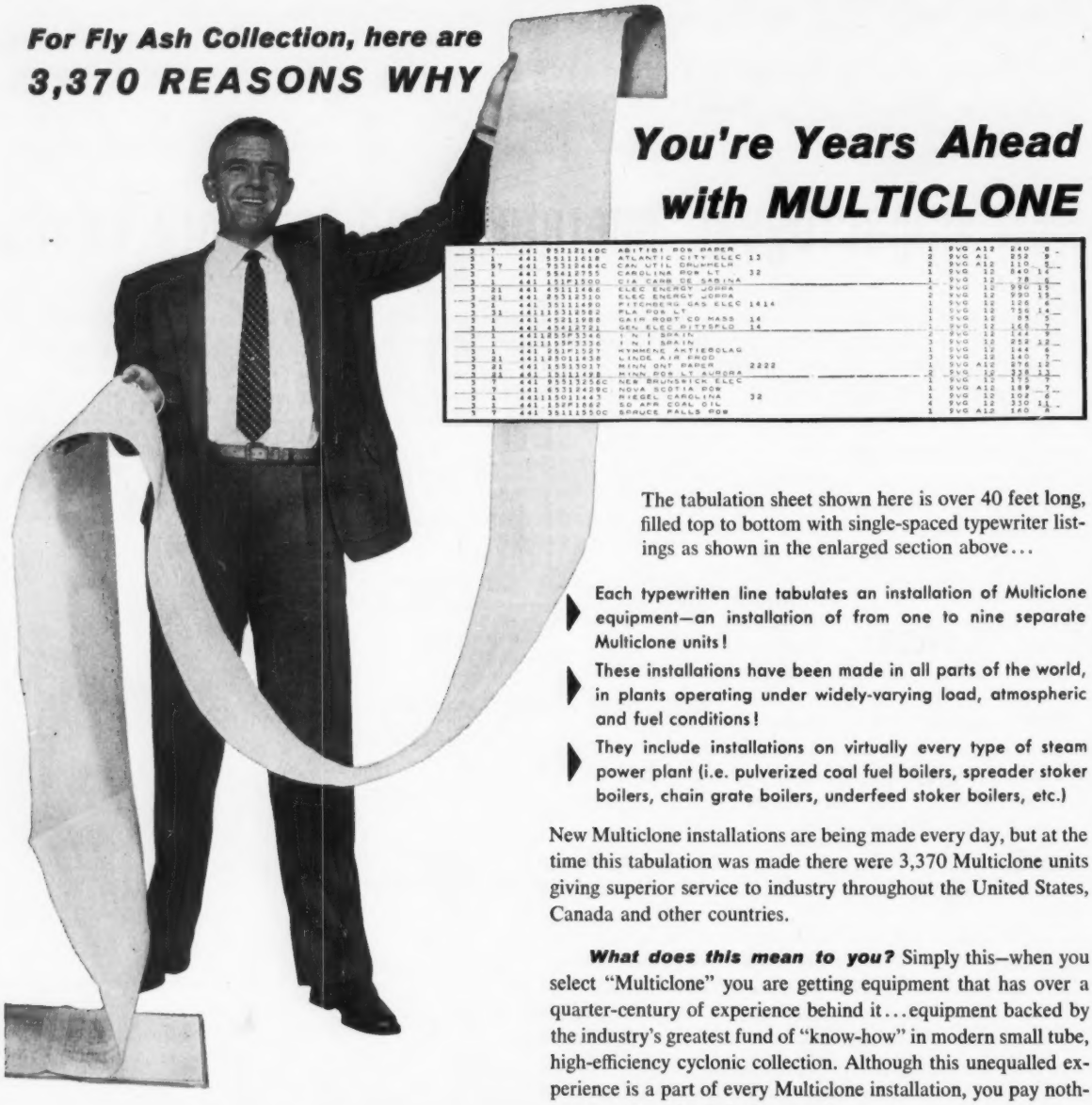
Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.



For more facts circle 233 on Reader Service Card, p 117

## For Fly Ash Collection, here are 3,370 REASONS WHY

# You're Years Ahead with MULTICLONE



The tabulation sheet shown here is over 40 feet long, filled top to bottom with single-spaced typewriter listings as shown in the enlarged section above...

- Each typewritten line tabulates an installation of Multiclone equipment—an installation of from one to nine separate Multiclone units!
- These installations have been made in all parts of the world, in plants operating under widely-varying load, atmospheric and fuel conditions!
- They include installations on virtually every type of steam power plant (i.e. pulverized coal fuel boilers, spreader stoker boilers, chain grate boilers, underfeed stoker boilers, etc.)

New Multiclone installations are being made every day, but at the time this tabulation was made there were 3,370 Multiclone units giving superior service to industry throughout the United States, Canada and other countries.

***What does this mean to you?*** Simply this—when you select "Multiclone" you are getting equipment that has over a quarter-century of experience behind it...equipment backed by the industry's greatest fund of "know-how" in modern small tube, high-efficiency cyclonic collection. Although this unequalled experience is a part of every Multiclone installation, you pay nothing extra for this vital advantage!

*Send For Descriptive Literature on Multiclone Equipment!*

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
HOLO-FLITE Processors
HI-TURBIANT Heaters

WESTERN
# PRECIPITATION
CORPORATION

Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

*Representatives in all principal cities*

**Precipitation Company of Canada Ltd., Dominion Square Bldg., Montreal**



For more facts circle 234 on Reader Service Card, p 117

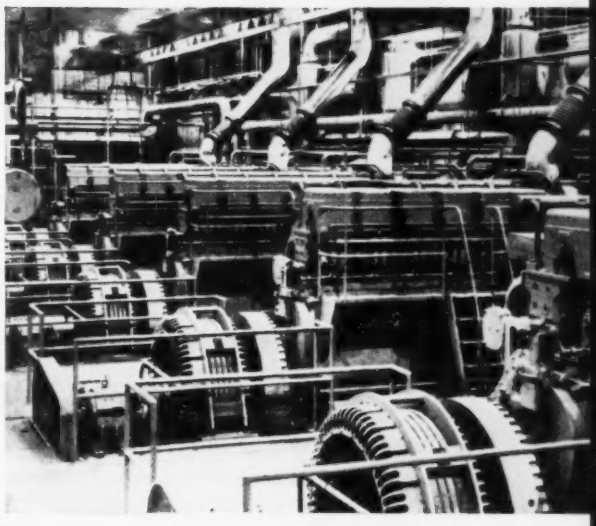
(official U.S. Air Force photo)

# NORDBERG ENGINES help power SAGE System Direction Centers of the Air Defense Command

"Master-minding" the tactical operation of U.S. Air Force interceptors like this F-102 jet is an amazing electronic air defense system called SAGE . . . *Semi-Automatic Ground Environment.* By analyzing a variety of air surveillance information which is received from a vast network of facilities and fed into electronic digital computers located at its Direction Centers, the SAGE System computes the speed, altitude, and direction of planes in flight to facilitate identification. A picture of the air and defense situation is displayed so clearly that Air Force personnel can quickly decide when and where to intercept, should aircraft be identified as suspect. The system also monitors the deployment of selected air defense weapons.

The Direction Center computing and display equipment relies on station-generated electric power. To help assure adequate power at all times, Nordberg Diesels have been installed in several Direction Centers.

*Nordberg Mfg. Co., Milwaukee 1, Wisconsin*



Nordberg four-cycle diesels installed in one of the SAGE system centers, generating electric power for the electronic computers, communications equipment, etc. Each of the Nordberg supercharged 6-cylinder engines is rated 930 hp at 450 rpm and is monitored electronically.

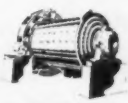
NORDBERG

© 1958, Nordberg Mfg. Co.

P658

SYMONS® CRUSHERS AND SCREENS

MINE HOISTS

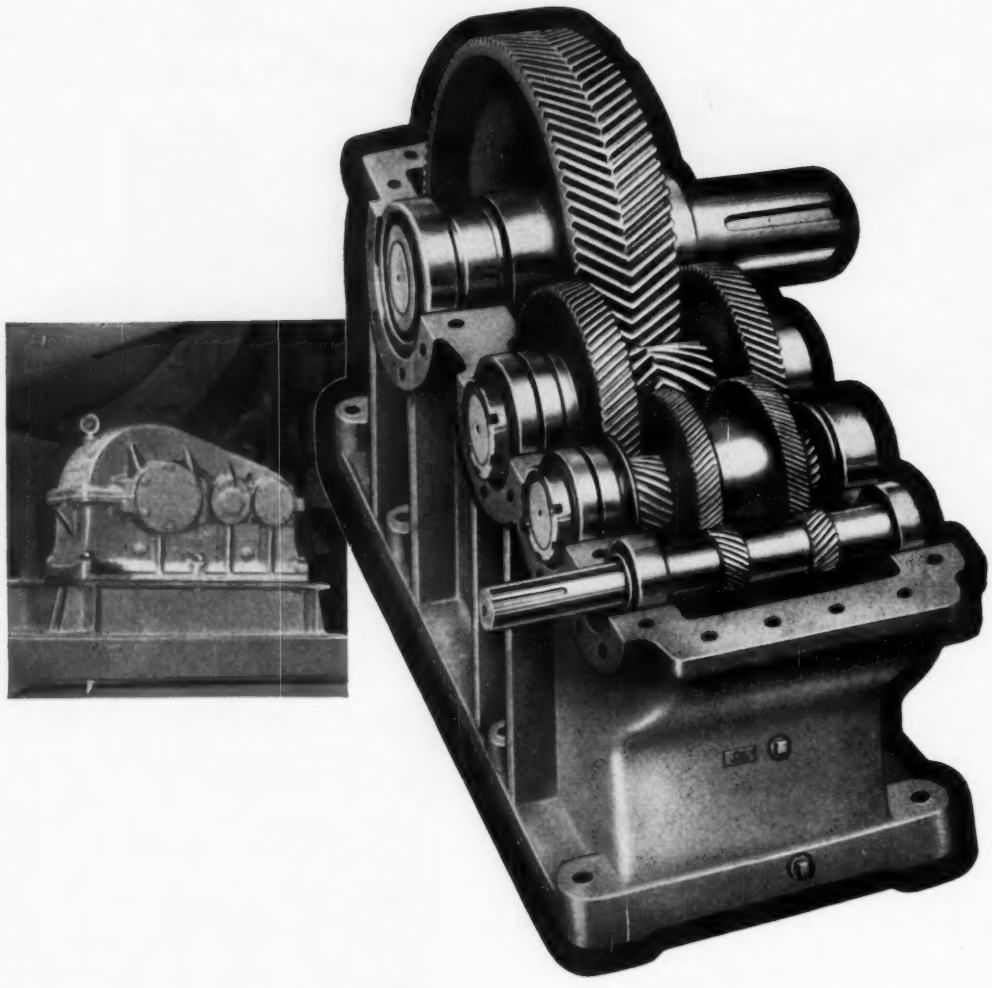


GRINDING MILLS—KILNS AND PROCESS MACHINERY

RAILWAY MAINTENANCE EQUIPMENT

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS • NEW ORLEANS • NEW YORK • ST. LOUIS
SAN FRANCISCO • TAMPA • WASHINGTON • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO, D. F.

**For more facts circle 235 on Reader Service Card, p 117**



## THE HEAVIER THE LOAD . . . THE MORE YOU NEED

# PHILADELPHIA HERRINGBONE REDUCERS

Heavy repeated shock loads . . . high horsepower . . . round-the-clock operation . . . put them together and you have the kind of a job where Philadelphia Herringbone Reducers perform best. They will last longer and save your maintenance dollars because extra strength is built into every part . . . housings, shafting, bearings and gearing.

To be specific:

Housings are specially reinforced at points of greatest stress. Extra heavy bearings take shocks and heavy overhung loads in stride. Result: shaft alignment is accurate . . . and it stays accurate. Gears, pinions and bearings last longer.

To meet the specific needs of each application, gearing is specially designed and symmetrically arranged in the housing. Result: the bearings on each shaft carry equal loads, shaft deflections are minimized, bearings and gearing have higher shock load capacity.

Pound for pound, horsepower for horsepower and dollar for dollar, you can't buy a herringbone reducer that will outlast a Philadelphia. They are designed with *your* heavy duty drive problems in mind . . . so that you will never have a drive problem.

Philadelphia Herringbone Reducers are available in single, double and triple reduction for ratios of 1.75:1 to 292:1. Write today for your copy of Catalog H-55.

**PHILADELPHIA GEAR CORPORATION**

Erie Avenue and G Street • Philadelphia 34, Pennsylvania

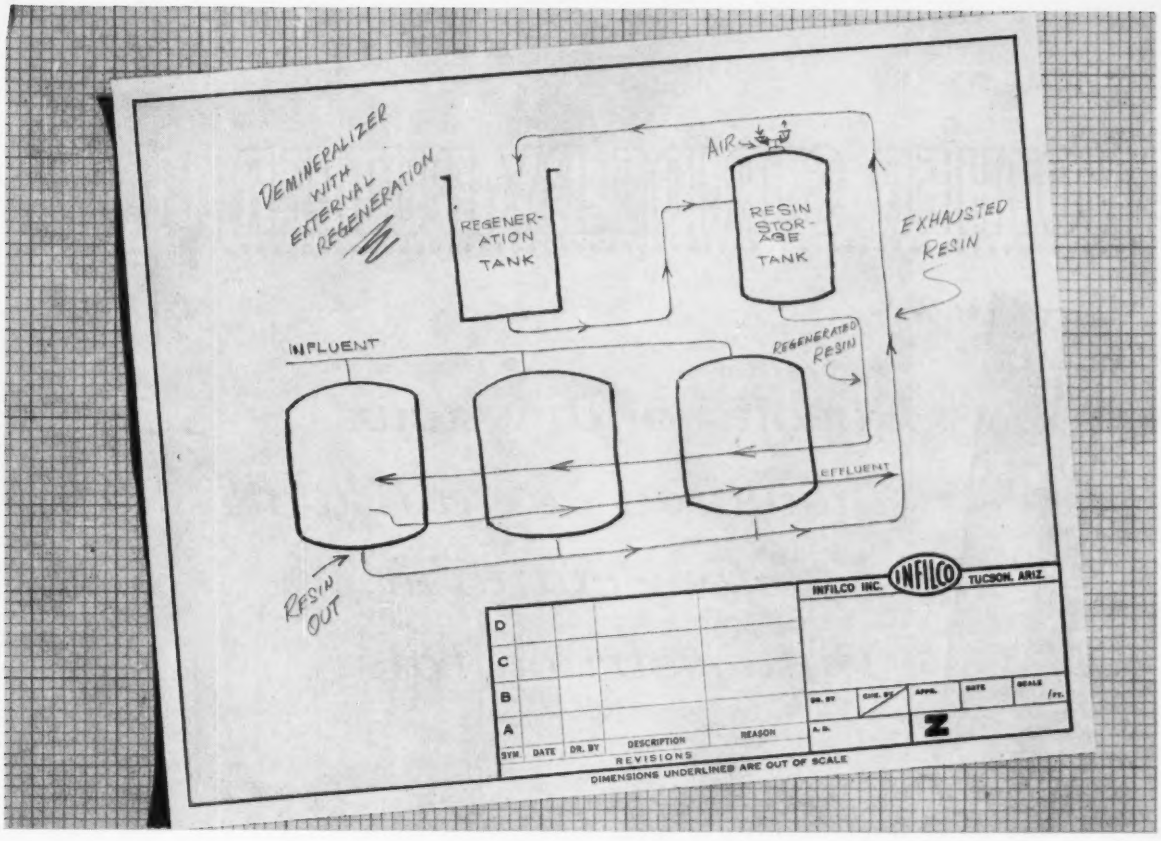
# philadelphia gear drives

Offices in all Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS



For more facts circle 242 on Reader Service Card, p 117




# ADVANCED demineralization equipment

## ...for specialized applications

Varied and increasingly stringent demineralized water requirements necessitate custom-made methods and equipment for many applications. Through the years INFILCO has furnished equipment for many of these "problem" jobs. These are typical examples—

INFILCO furnished the *first* high flow rate demineralizers (50 GPM per square foot) to polish condensate for a nuclear power reactor. This equipment has been operating successfully for over a year at the Vallecitos Atomic Power Plant of General Electric Company and Pacific Gas and Electric Co.

A similar INFILCO plant, having a capacity of 3200 GPM at 50 GPM per square foot, with complete external regeneration facilities, will polish condensate for the 180,000 KW dual cycle boiling water reactor at the Dresden Nuclear Power Station of Commonwealth Edison Company. This plant is discussed in Reprint 88.

Now INFILCO can furnish equipment, using these modern operating and regeneration techniques for large raw water demineralizers to produce high quality water, with less investment than would be required with other types of equipment. Reprint 92 tells the complete story.

If you have a demineralization problem, we can help you solve it efficiently and economically. If our standard line of equipment does not meet your particular requirements we can offer a custom designed plant to do the job.

INFILCO

8501

**INFILCO Incorporated**
*General Offices:*
*Tucson, Arizona*

Field Offices throughout the United States and other countries



For more facts circle 236 on Reader Service Card, p 117

# ANOTHER STRIDE BY BUTLER ▸ toward

## *Revolutionary new insulated curtain wall factory cut to fit Butler structurals*

Someday soon, complete industrial and commercial buildings will be factory-fabricated, and assembled from standard parts on the site. The Butler system of pre-engineered buildings has already made rapid strides towards this goal.

Now Butler announces Monopanl®. . . a new factory-fabricated, factory-insulated wall panel. Monopanl creates the entire exterior wall, complete with decorative outer face, insulation and finished interior face. Each panel is factory-sized for precision fit on Butler structural systems. Monopanls are merely bolted in place. Your building is completed with incredible speed. The result – an attractive building that will compare in quality to the best traditional construction, yet will conserve your capital.

With new Monopanl, Butler now offers the most advanced pre-engineered . . . factory-fabricated system of building for commerce and industry. Get all the facts and learn about Butler financing from your nearest Butler Builder. He's listed in the Yellow Pages under "Buildings" or "Steel Buildings." Or write directly to us.

from a design by
A. Francik and
Associates, Architects

BUTLER®

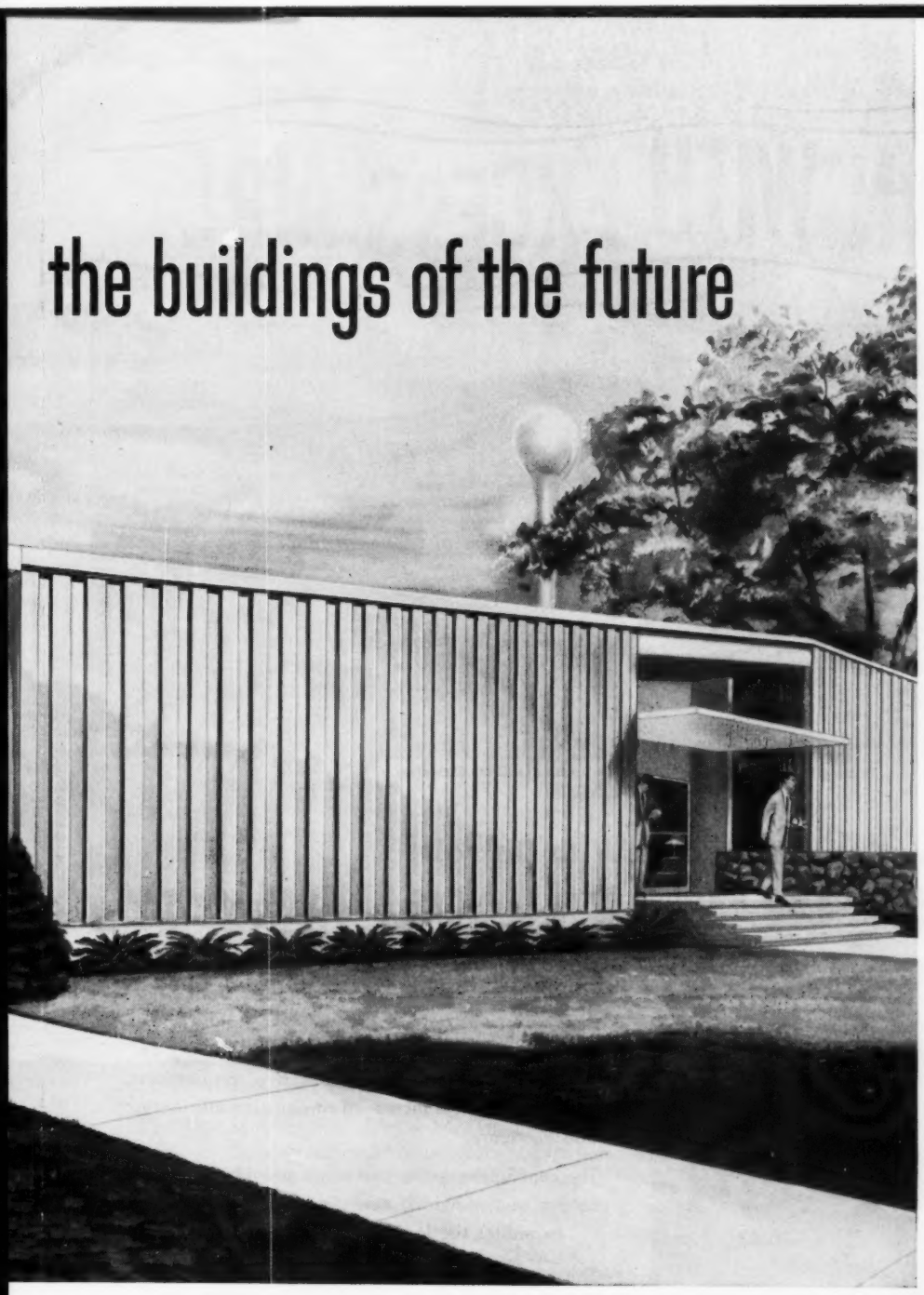
**BUTLER MANUFACTURING COMPANY**
7530 East 13th Street, Kansas City 26, Missouri

**Manufacturers of Metal Buildings • Equipment for Farming, Dry Cleaning, Oil Production and Transportation, Outdoor Advertising • Contract Manufacturing**

Sales offices in Los Angeles and Richmond, Calif. • Houston, Tex. • Birmingham, Ala. • Kansas City, Mo. • Minneapolis, Minn. • Chicago, Ill. • Detroit, Mich. • Cleveland, Ohio • Pittsburgh, Pa. • New York City and Syracuse, N. Y. • Boston, Mass. Washington, D.C. • Burlington, Ontario, Canada

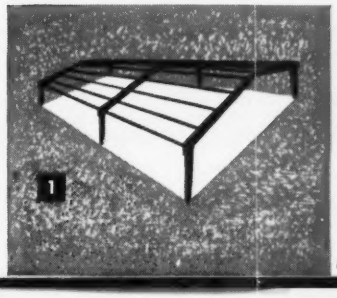
**For more facts circle 237 on Reader Service Card, p 117**

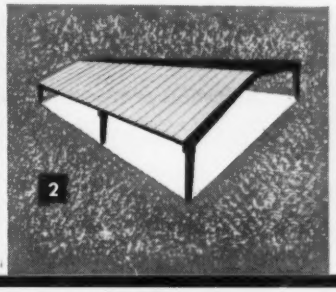
# the buildings of the future

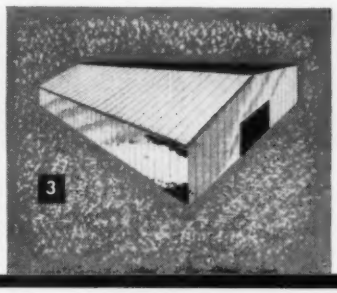


## Now, more than ever, the fastest, lowest-cost way to build well

Butler pre-engineered components fit together so perfectly that construction is little more than an assembly job. 1. Butler structurals are bolted together and erected. 2. The Butlerib roof is attached. 3. Monopanl walls are installed by simply pushing together and fastening to the structurals top and bottom. Your building is completed and you're in business, earning profits weeks, even months sooner, than ordinary construction methods would have permitted.



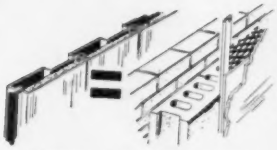




### How Monopanl creates a superior wall

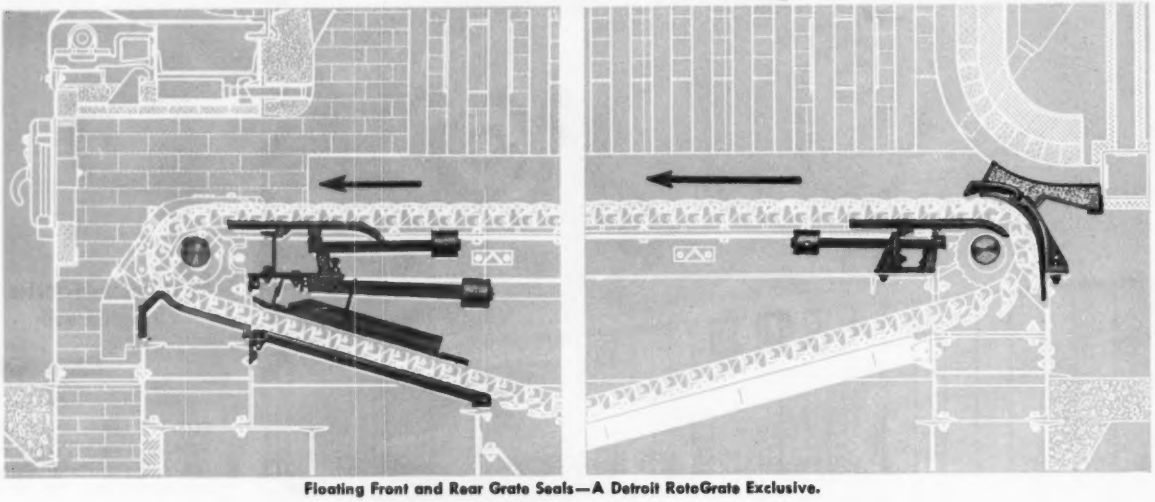
Each Monopanl is literally a metal plank with insulation between metal inner and outer faces. The complex configuration makes Monopanl the longest spanning . . . most rigid panel of its type.

The unique double tongue and groove design creates a strong panel-to-panel joint. And double vinyl gaskets permanently seal out moisture, last the life of the building.



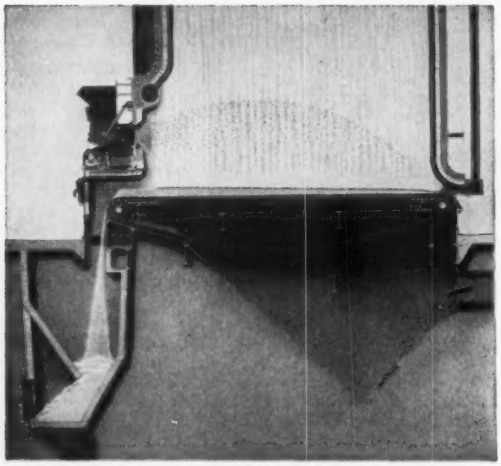
Monopanl is only 3 inches thick, yet is equal in insulating ability to a masonry wall of 4 inches of brick, 8 inches of concrete block, 1 inch of rigid insulation with air space and ½ inch of plaster.

# DOWN WITH EXCESS AIR!



Floating Front and Rear Grate Seals—A Detroit RotoGrate Exclusive.
They decrease excess air.

## Automatic Air Seals Exclusive With Detroit RotoGrate Stokers Reduce Excess Air to 22% and Lower



Detroit RotoGrate Stoker — an advanced design spreader stoker with forward moving grates, for medium and large boilers. Burns all ranks of bituminous coals and lignites without special preparation . . . also many waste or refuse fuels, either alone or in combination with coal. Efficiency is high — maintenance low.

Many users reduce excess air to 22% or under, due to these free floating automatic front and rear seals with adjustable counterweights. They really seal, and stay sealed even after years of service. Air is directed to the active combustion zone. The result is increased combustion efficiency and economy.

The rear under-grate seal plate provides a quiet coking section which extends across the furnace . . . expedites the ignition of green fuel.

These and many other exclusive features of advanced design make Detroit Stokers your best buy. There is a type and size Detroit Stoker for any boiler capacity from 3,000 to 400,000 pounds steam per hour.

**DETROIT STOKERS COST LESS: COST = INITIAL INVESTMENT + UPKEEP + PRODUCTION LOSSES DUE TO EQUIPMENT OUTAGE. THE TOTAL IS LESS WITH DETROIT.**

**DETROIT STOKER COMPANY**

**MAIN OFFICE AND WORKS • MONROE, MICHIGAN**

**District Offices or Representatives in Principal Cities**

8065



For more facts circle 238 on Reader Service Card, p 117

LOUIS N ROWLEY, EDITOR • APRIL 1959 • ESTABLISHED 1882 **Power**

# Personal growth

Last week I had the good fortune to hear that stimulating specialist in management development, Moorhead Wright. Of the many wise things he said one struck me as having key importance to all of us concerned with managing people.

Whether we supervise a small group, or head up a large staff, we all know that our success in large measure depends on how well the men who work with us develop their potential abilities. We're apt to think of this development process as *training*—and that, says Wright, is a basic mistake.

Training is what we do when we teach a seal to balance a ball on his nose. Training has its place, to be sure, but the growth that really counts comes from *self-development*. The real changes that make a man able to discharge greater responsibilities come from within.

In many cases the urge to grow is strong and evident. In others it is dormant and we must find the motivations, the triggers that will release it. And at all times we must maintain a climate in which self-development can flourish.

There are many positive steps that can be taken to encourage self-development. At the risk of breaking all the rules, and accentuating the negative, I'd like to look for a moment at some of the things we do, often subconsciously, that inhibit or even block self-development.

How often do we pay lip service to creative thinking and imagination and then slap down one of the boys who comes up with a novel idea? And how much growth have we stunted when we have a "serious talk" with the man who often approaches problems in an unconventional fashion and who ignores "time-tested" solutions? This doesn't mean accepting any cockeyed idea that's suggested. It does mean taking the pains to be sure the man knows his idea has been evaluated objectively and rejected for sound and practical reasons and not just because it was offbeat.

How often do we preach the importance of growing up in the job and then unthinkingly deny the opportunities to do it? Did we remember that Joe was finishing his education at night when we put him on overtime? Maybe it was necessary, but maybe we could have worked some other arrangement. Perhaps even more important, are we reluctant to give the "comer" the responsibility he needs to mature in judgment? Maybe we'll be put to some extra trouble by his ocasional mistakes, but that's the price of learning—and growing.

And how often do we complain that our men don't have the management point of view when we have insulated them from it?

We could go on listing other roadblocks unthinkingly placed in the path of the man who wants to develop himself, but there's no need to. The urge for self-development is a priceless asset, not only to the men who have it but even more so to those who manage them. It is tempting to think of the cultivation of that urge as something outside the day-to-day job—as the work of the specialist in "training." Such specialists can help, and organized development programs can be useful, but the real responsibility rests on us in our day-by-day role as managers. And when we create, for others, a good climate for personal growth, we too grow.

*Architect:* GRAHAM, ANDERSON, PROBST & WHITE, Chicago, Illinois
*Electrical Contractor:* HYRE ELECTRIC CO., Chicago, Illinois

# *Electrical Protection goes* MODERN *with BUSS fuses! . . . in the MORTON SALT BUILDING Chicago, Ill.*

The beautiful, new Morton Salt Building is located at 110 North Wacker Drive in Chicago — just outside the Loop.

The safest and most dependable electrical protection was needed because the engineers estimated the available fault current might easily reach a value of 75,000 amperes.

For this reason, the main switchgear, consisting of 1-4000 ampere, 1-2000 ampere and 1-1200 ampere pressure switch, is completely equipped with BUSS Hi-Cap fuses.

To make available the same safe, dependable and trouble-free protection, all distribution panels are equipped with FUSETRON dual-element fuses.

**THERE IS A BUSS OR FUSETRON FUSE FOR EVERY ELECTRICAL NEED**

## ONLY FUSES OFFER THE SAFETY AND DEPENDABILITY REQUIRED FOR TODAY'S CIRCUITS

Because of the ever-increasing transformer and network capacities, Power Companies now consider quite possible fault currents of 75,000 to 200,000 ampere.

So too, the requirements for protective devices have been changed to assure safe interruption of these higher fault currents.

Fuses, — because of their high interrupting capacity and dependability — prove superior in meeting modern protection requirements.

### With Fuses, Safe Protection Remains Safe

Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time. The operation of a fuse is not dependent on latches, triggers or other devices that are subject to the strains and jars of mechanical action — both in opening and closing.

A fuse cannot stick or fail to operate when electrical trouble occurs. 1 year, 5 years or 20 years from now, a fuse will provide the same, high degree of protection as on the day it was installed.

*Morton Salt Building: Mains and Feeders protected by BUSS Hi-Cap and FUSETRON Fuses*

*On installations of 0 to 600 amperes . . .*

**By Installing FUSETRON dual-element FUSES—YOU GET 10 POINT PROTECTION**

With rare exceptions, other types of protective devices protect only against short-circuits —

BUT, FUSETRON dual-element fuses give you safe, trouble-free 10 point protection.

*For the FUSETRON fuse story ask for Bulletin FIS.*

*For Loads above 600 amperes . . .*

**BUSS Hi-Cap Fuses offer Safest, Most Modern Protection**

They have an interrupting capacity sufficient to handle any fault current regardless of system growth — and by coordinating them with FUSETRON fuses on feeder and branch circuits, outages caused by fault currents can be limited to circuit of origin.

*For the BUSS Hi-Cap fuse story ask for Bulletin HCS.*

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**BUSSMANN MFG. DIV. McGRAW-EDISON CO. ST. LOUIS 7, MO.**

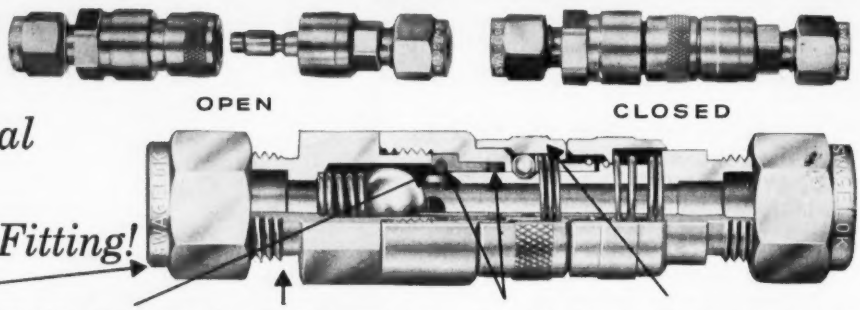


For more facts circle 239 on Reader Service Card, p 117

# What's the secret of this fast, positive-seal fitting?

Swagelok Quick-Connect Fitting Installation in Boeing Airplane Company, Seattle, Wash., Test Facilities for Boeing 707 Jet Stratoliner.

## *Here's the secret of this fast, positive-seal Swagelok Quick-Connect Fitting!*




**1.** Swagelok Quick-Connects with single end or double end shut off for tube to pipe, tube to tube, bulkhead tube to tube applications are available in brass and stainless steel in sizes for ¼" and ⅜" O. D. tubing.

**2.** Flow resumed instantly and vacuum tight seal assured when connection is made.

**3.** Light, compact, streamlined design. Occupies little space. For use with portable equipment, and bulkhead or panel applications.

**4.** Instant-acting seals completely prevent loss of pressure when fitting is disconnected.

**5.** No twisting, turning or wrench action necessary. Easy straight-line finger tip pull or push action for instant connecting or disconnecting.

In the Boeing Airplane Company photo shown above, the tubes are instrumentation pressure lines running from the large jet engines on test stands to the patch board, where the lines are coupled into measuring devices.

The Boeing Airplane Company adopted this positive Swagelok Quick-Connect Fitting to simplify test installations, and substantially cut down test set-up time. Both ends of the many pressure lines are Swagelok-equipped. Previously, engineers used a screw-type fitting which required a wrench and valuable time-consuming operations to tighten and remove.

Swagelok engineers are equipped with experience, ability, and a wide range of tube fittings designed to meet your individual problems. Quick delivery of Swagelok tube fittings from local distributor stocks.

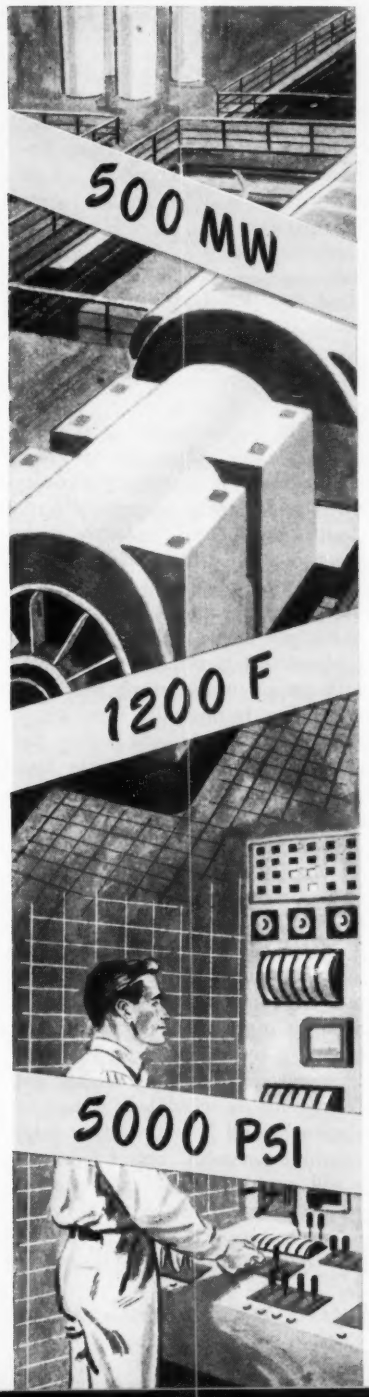
**Swagelok® TUBE FITTINGS**

**CRAWFORD FITTING COMPANY**
**884 East 140th Street, Cleveland 10, Ohio**
**Crawford Fittings (Canada) Ltd., Niagara Falls, Canada**

**For more facts circle 240 on Reader Service Card, p 117**

Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge




# Supercritical pressure: a new control problem

**Unit size, ability to handle quick load changes, make fast response and precise control pay dividends**

**Once-through steam generators now use simpler control systems, have fewer time lags than conventional boilers**

**Further integration of steam generator, turbine controls should simplify future systems**

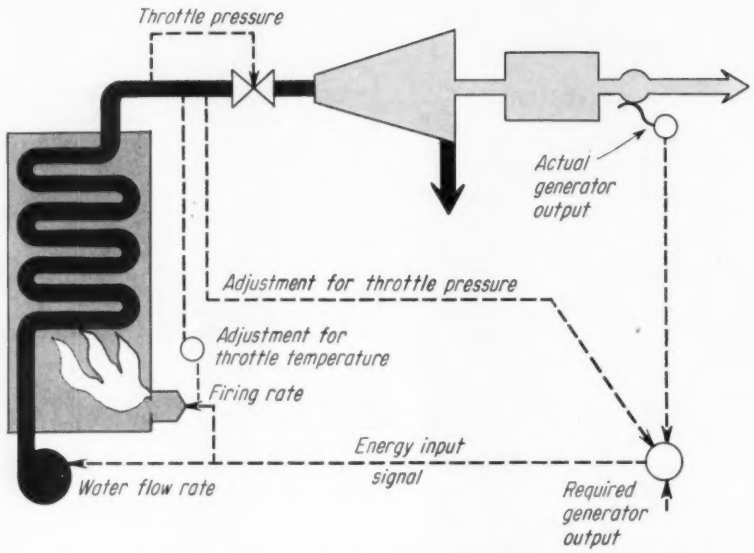
By L E STEWART, Assistant Editor

Supercritical pressure cycles hit the news several years ago. Since then various cycle modifications, pressure and temperature ranges have been explored, and engineers are beginning to collect actual operating experience. We can now stop to analyze present control philosophy and take a better look at possible future control systems.

First, we must look at the basic cycle to see just what is different about supercritical unit control. Supercritical-pressure once-through units feature sharply reduced heat-storage characteristics, hence give rapid response to operating changes. To control such a unit you must have near simultaneous reaction of fuel, air and water input.

Once-through boilers can be designed for practically any capacity and are economically feasible for 1800 psig and up. However, for supercritical-pressure operation, cycle limitations may force turbine-generator units to capacities far exceeding today's standard sizes. This is the final horn of the control engineer's dilemma: superpressure usually demands supercapacity, resulting in superlosses from even small operating errors. Control problem boils down to a cycle which can use simplified control systems and needs fast and extremely accurate reaction.

**continued**




**CYCLE CONTROL** uses new, but tried techniques in balancing generator load demand against energy input. Steam temperature and pressure may adjust input signal as a trimming action

## Unit control balances heat input against generator load

Unit control systems, to date, follow contemporary practice. Basic control systems for plants already on the way contain variations of the diagram above. These systems often use required generator output as the controlling impulse for fuel and water feed rates. In essence, this directly balances energy input against energy output. Where generator load does not directly control input a more conventional pressure actuated system may be used. This method usually takes turbine first-stage pressure as a boiler master signal.

Because of the once-through steam generator's high speed of response, so-called series control operation is often impractical. Parallel control action sends simultaneous signals to change water flow, firing rate and air flow. Trimming action of auxiliary controls is deliberately limited so rapid load swings don't result in overcorrection.

So far, steam generator and turbine control systems have been engineered separately and combined in a final step. This design approach results in some duplication of function between steam generator and turbine controls.

One important and troublesome control is removed—water level. This control required anticipating signals equivalent to steam flow since steam-drum water level is too insensitive to sudden load change. With level control out of the picture, steam flow measurement is no longer needed for any control operation. This will make instrument engineers happy because steam-flow measurement has become an expensive and complicated procedure.

Various feedback or trimming signals may be included in the basic unit control to give anticipating action or fine regulation. Actual generator output can operate as a reset and trimming impulse to the energy input control. This auxiliary control is important in compensating for sluggishness or backlash in turbine throttle valves. Throttle pressure may also act to cut load if the steam pressure drops below safe figures. One system, described in the following pages, integrates temperature and load control loops by adjusting firing rate to maintain throttle steam temperature. Again adjustment is limited to trimming.

Balancing input with output usually starts with water flow control. Feedwater flow is normally regulated by controlling pump speed. Motor-driven units include fluid couplings while turbine drives employ variable speed controls attached to throttle valves. Measured feedwater flow supplies a reset signal to the control and sets the limit for minimum flow.

Combustion control may operate directly from an energy input signal or may balance against measured feedwater flow. In either case, fuel and air flow position in parallel and air flow is adjusted for combustion balance. Although air flow positioning may be on the basis of a set fuel-air ratio, final trimming usually depends upon continuous flue-gas analysis by an oxygen recorder.

Turbine-generator control moves slowly toward load supervisory control. Several units will have remote manual load control. Later systems are scheduled for modified automatic load regulation or full balanced input-output control. The rest of turbine-generator control is conventional and probably will remain so until boiler-turbine cycle controls are integrated into one system.

Although operating experience with these systems is skimpy, initial reports are heartening. Test results and

operating experience on the first unit indicate turbine trips and hot restarts can be accomplished without upsets in steam pressure or temperature charts. This hair-trigger response is a function of the cycle and offers a degree of operating flexibility never before possible.

Hand-in-hand with increased flexibility goes a demand for faster, more accurate control action—not because once-through units are more difficult to control, but because their operating characteristics allow us to take advantage of higher response speeds and accuracies.

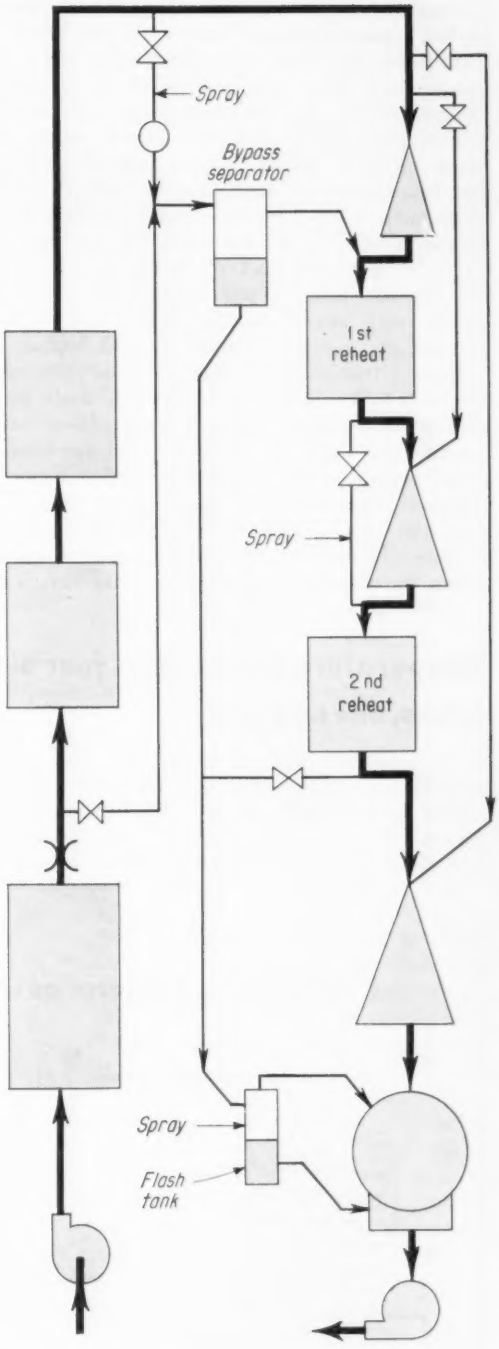
## Bypass control smooths operation during startup or shutdown

Turbine bypass system is the key to once-through operation, maintaining minimum water flow rates at startup or low-load operation. Integration of bypass into the overall system control allows a smooth swingover from on-the-line to bypass operation. Hot starts following unscheduled turbine trips are a major operating problem for modern high-pressure high-temperature turbines. The bypass system allows precise matching of turbine metal and throttle steam temperatures.

As with overall control, basic flexibility and speed of response of a once-through unit places demands on control elements and instrumentation for high speed and high accuracy. Plant cycles and equipment design determine bypass arrangement and operating method. Bypass system, right, depends on spray desuperheating, throttling bypass valves and flash tanks to reduce temperature and pressure of steam bypassed around each turbine. These control stations must react instantly when a turbine trips. Too, they may be capable of picking up full steam flow. Although shown as one reducing valve in the illustration, each point usually consists of several valves in parallel. This reduces size of valves and gives extended control range by sequencing valves to open as each preceding valve becomes fully loaded.

One alternate design uses flash tanks and heat exchangers for temperature reduction. This circumvents problem of trying to measure steam temperatures at or below saturation. Either bypass system requires speedy control reaction to changes in temperature or pressure. Pressure measurement poses no new problems in this control system since conventional instrumentation handles rapid fluctuations adequately. Temperature measurement and control is another story. Time lags created by thick-walled temperature wells are a built-in trouble with any system, and harder to correct. One possible solution to this problem involves anticipating signals and parallel control action of the bypass valves during on-stream periods. This would take complicated controls.

Bypass valves in system at right shunt steam around each turbine section and around the superheater. Extraction valves bypass steam during operating upsets or very special conditions as protection for generating sections. The combination of various bypass operations permits the once-through unit to cope with operating upsets which would knock out conventional plants. Use of this extraction system limits temperature shock in the superheater and piping on loss of fire. It also gives a




**Bypass creates cycle flexibility**

Multiple lines let cycle handle unbalanced temperature, pressure or absorption. Superheater bypass helps match boiler outlet, turbine temperatures also control absorption. Turbine bypass prevents throttle overpressure

helping hand to other bypass sections in matching temperatures. Some units bypass the entire turbine, discharging to the hotwell. In these cycles reheater surface is arranged so steam cooling is not required at low load.

Auxiliary controls operate within the basic framework of the bypass system to limit or adjust bypass flows. Turbine bypass valves act as relief valves which open at overpressure. This ability to control turbine supply and backpressure is also important during hot restarts.

Automatic action of bypass valves permits smooth swingover from startup cycle to on-the-line. When turbine temperatures are matched, or on startup when desired steam temperature is reached, load is manually picked up on the turbine. As turbine steam flow increases, bypass valves automatically back off to maintain constant turbine throttle pressure and boiler load. When bypass valves reach closed position, boiler and turbine are matched and ready for immediate load control.

Boiler extraction or superheater bypass valves normally discharge to the condenser. During cold starts, interlocks prevent these valves from opening. Also, overriding controls limit valve opening if the condenser cannot condense bypassed steam without excessive temperatures. Bypassed steam sent to injection coolers in the condenser neck may be sprayed to limit turbine exhaust-hood temperature. In this case, overriding controls would go into action when spray water reached its ultimate capacity.

## Temperature control uses four old tricks, one new one

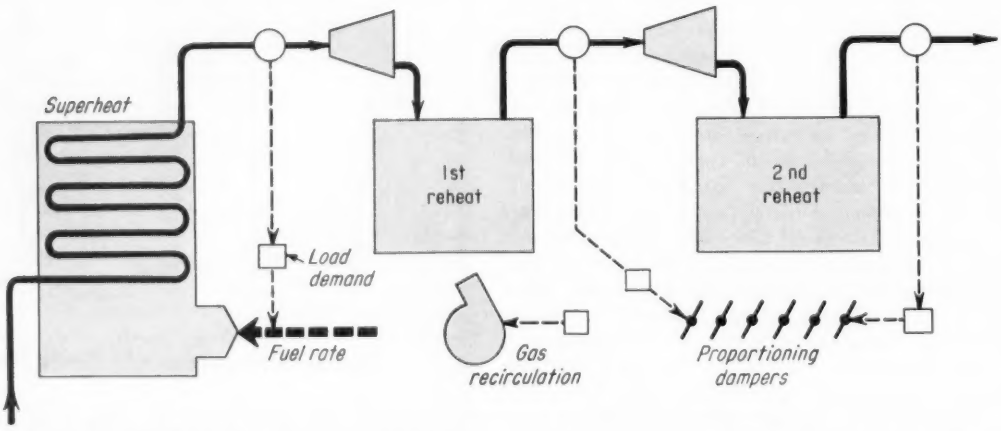
Steam temperature control for all units planned to date employs spray desuperheating, controlled heat absorption or a combination of both. The diagram below outlines a control system using three variations of absorption control to hold steam temperatures in line. As described in earlier section on overall control, this system regulates water, fuel and air flows as generator load demand varies. However, firing rate is adjusted by turbine throttle temperature. In effect, firing rate is positioned by generator load and controlled by steam temperature. This system, in common with most parallel controls, usually hits pretty close to temperature; throttle temperature control merely adjusts for variations in operation. Firing to control temperature is a new concept developed with today's tri-fuel plant in mind. Controls are simpler than conventional systems.

Reheat steam temperatures are regulated by a second form of absorption control: gas recirculation and gas bypassing. Reheater surface is placed so the weight of gas flowing across the section is prime factor in heat absorption and steam temperature. Fans pump relatively cool gas into the furnace to temper gas entering tube banks and to increase amount of gas flowing across reheater tubes. By proportioning flow of this recirculated gas to load, reheat temperatures are maintained over the load range. Gas recirculation flow is positioned by the input signal and trimmed by furnace temperature.

Second reheat steam temperature is regulated by a modification of gas recirculation flow. First and second reheater sections are side-by-side in the tube banks in classic gas bypass arrangement. Dampers at the boiler outlet bias gas flow to control steam temperature. The increased gas flow created by gas recirculation serves to increase effect of gas biasing with dampers. At the same time regulated gas temperature produced by combined effects of gas tempering and firing for steam temperature lessens need for backup spray.

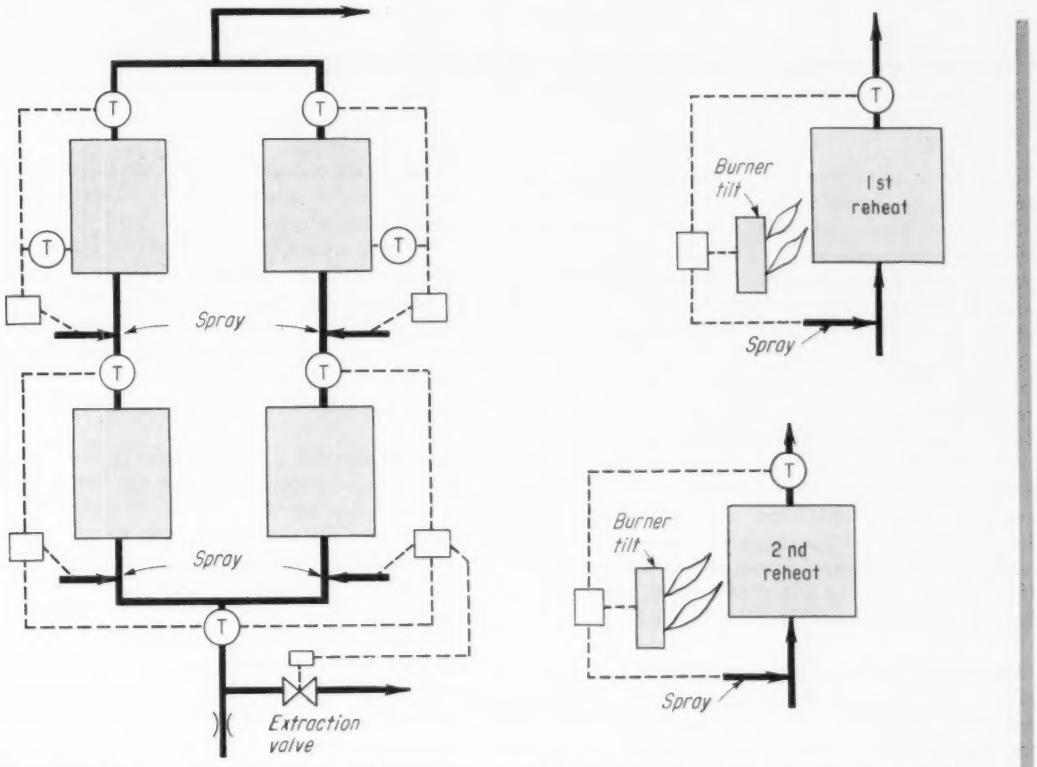
Reheat control combines positioning and trimming since initial positioning of firing control and gas recirculation usually results in reasonably close steam temperatures. This prevents exaggerated control situations needing excessive biasing of dampers. Because temperature controls operate, in effect, as trimmers, anticipating

**Controlled heat absorption regulates steam temperatures from gas side**




**GAS SIDE CONTROL** includes new concept of firing for temperature as superheat regulation. First, second reheaters get temperature control from gas recirculation. Proportioning dampers at boiler outlet trim reheat temperatures

## Combined spray, heat absorption control temperatures in alternate plan




**SPRAY CONTROL** teams with twin furnaces and burner tilt to regulate superheat and two reheats. Superheater surface in each furnace path has 2-stage spray attemperation. Back-up sprays control reheat temperatures during upsets

signals are not usually included in the system and time lags inherent in the use of temperature wells do not curtail the response speed of the system.

Firing for temperature and controlling tube-bank absorption can simplify control of multi-fuel units and correct for common operating variables such as changes in furnace slag coating or tube-bank fouling.

## Spray temperature control remains a favorite technique

Spray attemperation for steam temperature control combines with a third method of heat-absorption control in the illustration above. To date, this and the system on the opposite page represent the only basic approaches tried in this country. With the combined spray-absorption control, sensitive high-speed temperature measuring instruments combine with anticipating signals to give trigger action. Superheat control also involves a modified positioning action which can be designed into the supply section of the spray attemperator lines.

First, let's look at reheat control. The setup for first and second reheat is identical. The steam generator is designed as a twin-furnace unit with one reheater in each furnace pass. Final steam temperature for each reheater regulates gas temperature in its furnace. The temperatures are varied by tilting burners or biased firing of multiple-level burner sets. Spray attemperators at the reheater inlets act as backup control during upsets or special operating situations.

Superheat control depends on 2-stage spray attemperation to do the whole job. Superheater surface splits into parallel paths for each furnace, with a primary and secondary section in each path. Spray reduces steam temperatures entering each section so job of attemperating is not heaped on one station, and excessive superheat at exit of first section is avoided.

Basic temperature impulse comes from each section outlet temperature. Primary superheater sections get anticipating signals from inlet steam temperature and total flow to the superheaters. Since primary outlet temperatures are controlled, anticipating signals for the second spray points are taken from selected tubes in the cold portion of the secondary superheaters. Unbalance between spray quantities for each path are primarily the result of any difference in firing between furnaces occasioned by reheat control.

Built-in spray positioning results from water supply takeoff between feedwater valve and pressure differential valve. As load varies on the unit, spray-water-supply pressure varies proportionately and attemperator valves move only enough to trim flow.

**continued**

## How will engineers control future supercritical pressure systems?

Today, there are as many variations of the basic control systems as there are units going into service. In the majority of cases these first few cycles feature several alternate modes of control in parallel and a certain degree of over-instrumentation. This offers extreme operating flexibility and an opportunity to learn a great deal about cycle characteristics. As operating experience piles up, control systems should become much simpler and, because of a better understanding of the effect different variables have on operation, should also result in even faster, more direct control reaction to operation changes.

A separate area of research will accelerate control problem solutions. Analog simulators are condensing years of operating trial and error into a few months. Initial operation of one cycle revealed excellent agreement between simulator results and actual performance. If we expand simulator use in control design, we can have simplified systems in a few years.

**Combustion and fuel input control** will occupy a lot of the control engineer's time. Fuel rate often turns out to be the slowest element in load change for once-through units. Direct control of fuel rate by generator or turbine load gets around the problem, but engineers intend to spend a lot more effort on development of faster fuel rate reaction.

Engineers expect to stay with positioning control of fuel and air from a master signal, with trimming action of air flow presumably by an oxygen analyzer.

Direct measurement of air flow may enter the picture as a reset signal, but some form of flue-gas analysis will be needed to handle variations in fuel or operating conditions. Continuous, multipoint gas analysis will call for added research into sampling techniques.

**Bypass control systems** often use single-element series control of desuperheating stations. Apparent trends in this field run to multiple desuperheating stations in series and parallel, with final stages of desuperheating controlled on a Btu basis. This method gets around the problem of temperature measurements in steam lines at or below saturation. In addition, one input signal can control several desuperheating stations in series with adequate accuracy. Since Btu measurements must be made before the desuperheating station a built-in anticipating action solves problem of series control for a system at standby one minute and full load the next.

Pure cycle economics dictates further tapping of heat saving in bypass steam. Bypass pressure and temperature break down in stages, so steam could bleed to feedwater heaters during off-line periods.

**Steam temperature control** probably will show the greatest strides in simplification. Present designs often include several alternate methods of control in parallel or at least multiple sampling points for prime temperature measurement. Many of the systems employing anticipating signals may eventually do away with this item because the basic control will be able to handle any temperature swings. Also, there are indications the once-through unit can handle uncontrolled transient or unbalance problems better than a conventional unit.

**Overall control** of supercritical cycles stands to gain from simplification. What now amounts to several control loops tied together as a loose package will eventually combine as one integrated loop minus all duplication and control of intermediate points. Recording, indicating and controlling instruments will combine with computer-operated data logging, programming and trimming.

Present use of data logging usually adds further duplication to already redundant control systems. But data loggers can take the place of many present-day instruments if measurement use is sensibly broken down into operating setpoints, trend guides, alarms and overall performance factors. Much plant information not needed for day-by-day operation would be stored in final form and building space and instrument cost would be credited to the logging system. Alarm systems logically fall in the area of data logging. Set limit alarms offer no real saving, but computer-operated data loggers allow set-point of alarms to be varied with load or any other desired function. Also, rate-of-change monitoring has the advantage of anticipating trouble before it shuts down your operation.

Programmed computer control does away with the need for interlocks and overriding control. The original single-mindedness of computers has been overcome, so data loggers can handle several jobs at once. Future systems will handle data logging, alarms, operation programs and performance trimming simultaneously, and be able to take the place of many of today's control-room instruments. Versatility of this control would match the once-through cycle's high speed response and flexibility.

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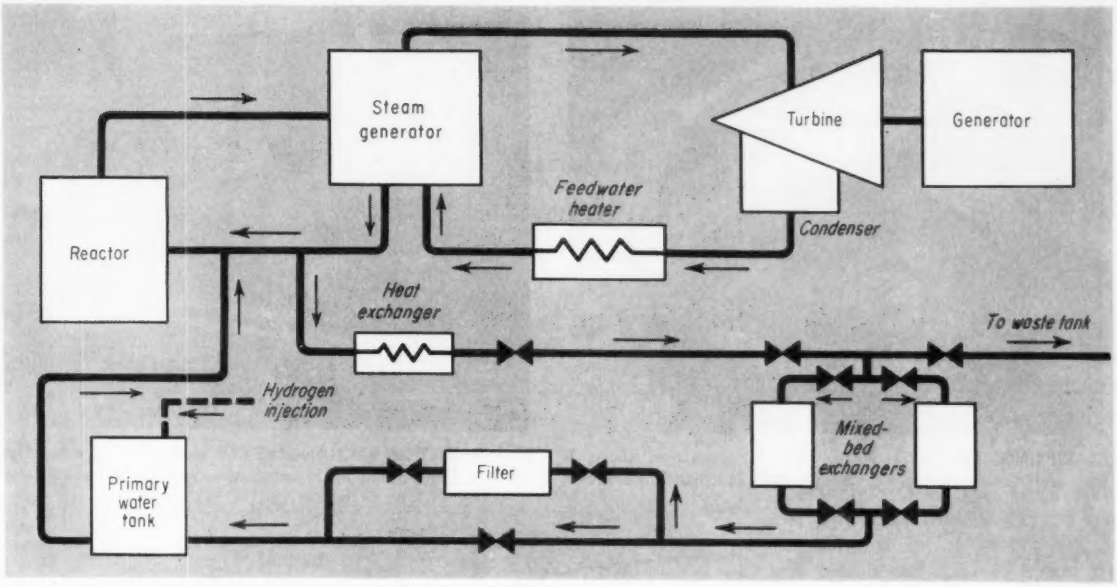



**PRIMARY COOLANT SYSTEM** of Army Package Power Reactor uses mixed-bed exchangers and filters in series to remove ionized and solid materials. This equipment is located in bypass loop and fed by main loop blowdown at reduced pressure and temperature

# Treating water for nuclear reactors

**Solids and dissolved gases in primary cooling water cut efficiency, complicate maintenance. Concluding article of this 2-part report shows how filters, ion exchangers and chemical feeds cope with impurities, prevent corrosion**

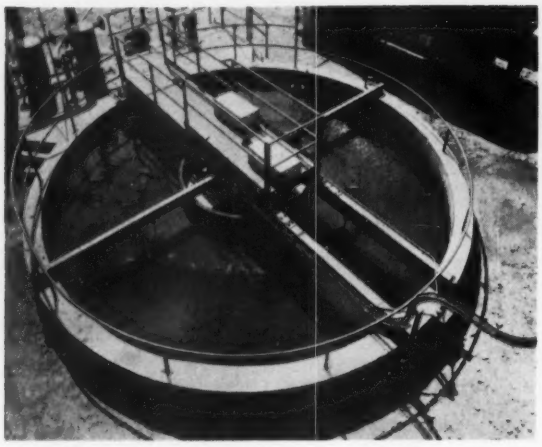
By C T DICKERT, R HETHERINGTON and C F RAINES, Rohm & Haas Co

New problems with radioactive water are covered in Part I, POWER, September 1958, pp 88-90. Basic treatment job is to keep water quality up to par in spite of the fact that impurities are continually formed within the primary loop. Treatment goals are to (1) remove maximum amount of dissolved and suspended solids plus dissolved gases (2) keep water noncorrosive to limit formation of additional impurities in the system.

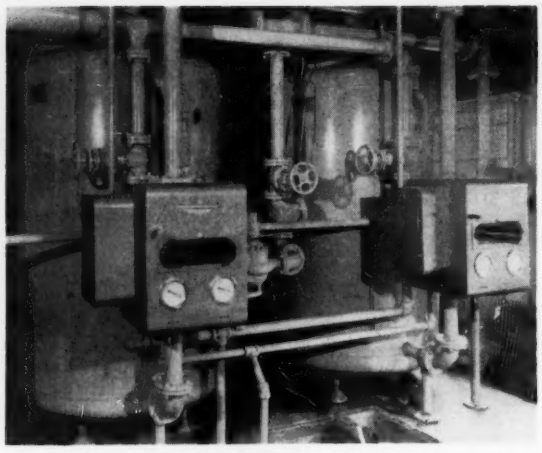
**Ion exchange** is the heart of all primary water treatment. It's the most efficient way to purify highly dilute solutions typical of primary coolants and to produce water with resistivities of over one million ohm-cm. Ion-exchange systems prevent buildup of radioactive solids in the loop by removing all ionized materials. They also remove larger suspended solids by acting as a mechanical filter, and provide a safety feature by trapping any sudden influx of highly radioactive material released by fuel rod rupture. Ion exchangers have enough reserve capacity to avoid immediate shutdown of a reactor having a pinhole leak in a fuel element, and they offer a practical way of handling and disposing of radiation since system activity is collected and stored within a small physical volume.

Removal of ionized and solid material is usually done with a mixed or Monobed demineralizer system in series with one or two mechanical filters. If only one filter is used put it on the effluent side of the ion exchangers. General choice is stainless-steel micrometallic type capable of trapping solids with size in the order of seven microns.

Extremely high flow rates in the primary loop present a problem. In the Shippingport reactor it exceeds 45,000 gpm. Temperatures of 400 to 600 F and pressures of 1000 to 2500 psi in the water circuit are also difficult to handle. So it's impractical to pass more than a small fraction of the total volume of loop water through the exchangers at one time. Mixed-



**CLARIFYING** turbid Ohio River water in coagulator, above, is first basic treatment step at Shippingport Nuclear Power Plant



**SODIUM-CATION EXCHANGERS** then soften clarified water. Units are salt regenerated with automatic type single valves, above

## Clarifiers and ion exchangers play important treatment role

bed demineralizers and filters are put into a special bypass loop and fed with blowdown at reduced pressure in the range of 75 to 100 psi. Temperature is also reduced to about 120 F to protect resin from thermal damage. Blowdown rate is usually 2 to 5% of total flow. This varies with flow rate, impurity concentration and desired effluent quality.

**Mixed-bed units** are generally preferred over separate cation and anion columns because they have a higher decontamination factor (radioactivity of feed divided by radioactivity of effluent). H G Swope, *Journal of AWWA*, August 1957, reports a decontamination factor of 1400 for multiple beds compared with 17,000 for mixing bed. Both were measured at the point of total solids breakthrough. Incidentally, the cation bed alone had a decontamination factor of only 10 to 15. Feed used for these tests was tap water containing 250,000 counts per min per ml of mixed fission products. The mixed bed contained anion and cation resins in the ratio of 1½ to 1 to balance their exchange capacities.

Effluent from mixed-bed units will have a resistivity of 1 to 4 million ohm-cm with a pH of 6 to 7. Usually the breakthrough point is pegged at one million ohm-cm. Under actual operating conditions effluent quality is not greatly affected by flow rate.

Before reactor operation mixed-bed systems are also used to recover a 1½% boric-acid solution from the coolant loop used as a moderator following shutdown. The boric acid can then be eluted from the bed and stored for later use.

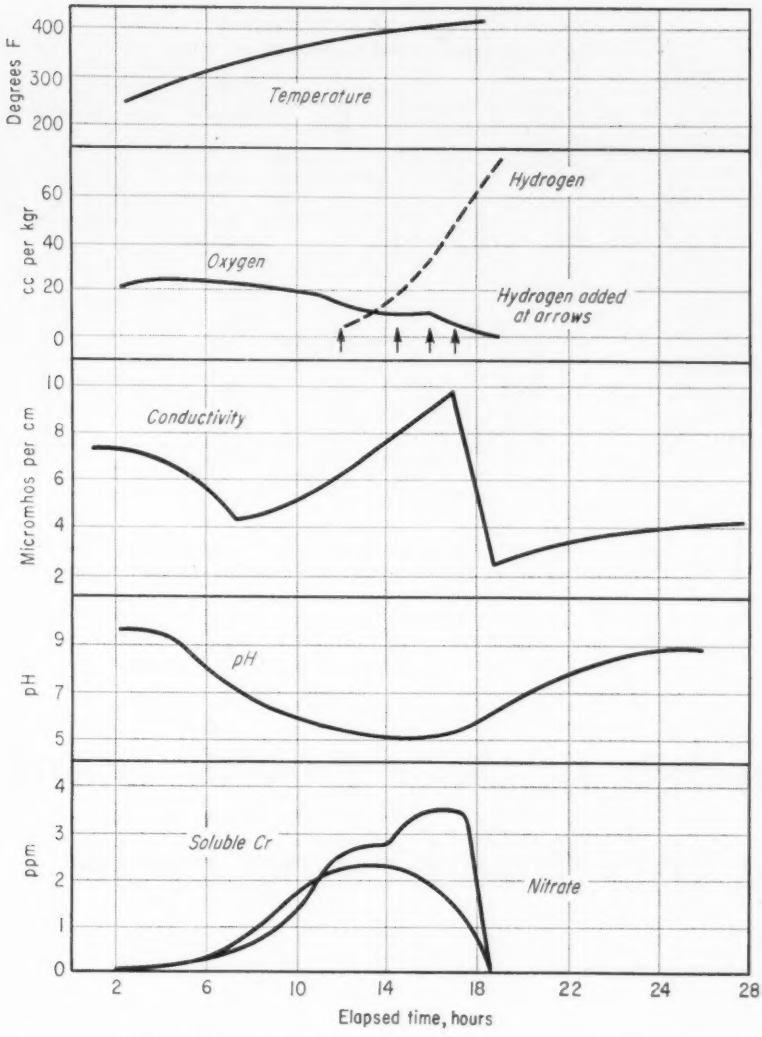
At present none of the operating reactors regenerate exchange resins after breakthrough. Volume of regenerating and rinse solutions is 20 to 30 times greater than volume of resin bed. So it's much more practical to handle radioactivity concentrated in the relatively compact volume of exchange materials. Another drawback is that the "hot" ion exchangers present an accessibility problem for regeneration. Elaborate safeguards are needed to isolate controls, piping and related regeneration equipment. In large installations the spent resin is removed by an ejector and flushed into a sealed container. Gravity feed is then used to recharge the column with fresh ion-exchange material. In smaller plants, such as the APPR at Fort Belvoir, the column and resins are discarded as a package and replaced by a new unit using quick-disconnect fittings.

**Corrosion control** in the primary loop depends on keeping an alkaline pH and removing the oxygen. By conventional standards the material loss from reaction between water and stainless steel is insignificant. A representative rate for this reaction produces a penetration of 0.001-in. in 16 years. Yet, even at this rate, one ounce of solids per day will be introduced into a typical primary loop. Importance of corrosion control measures is underscored by potential amount of radioactivity that can result.

**Special exchange resins** are frequently used to control pH. Effluent of the mixed bed has a pH of 6 to 7, but a pH of about 10 is desirable. Caustic cannot be used for pH adjustment because of the high activity of irradiated sodium. Most practical method is to use cation resin in either the lithium or ammonium form. Either of these is used in conjunction with an anion exchanger in hydroxyl form. They can be combined in a mixed bed or put in separate units. Effluent from this combination is alkaline since lithium or ammonium ions are released from cation resin instead of hydrogen ions. Since lithium forms a strong base, less is needed to raise pH to a given level. But, even though the ammonium hydroxide is a weak base, it has advantage of helping repress ammonia-synthesis reaction of nitrogen and hydrogen. This, in effect, increases hydrogen concentration. In the Shippingport reactor system pH is controlled by adjusting flow rate through a special cation resin.

**Oxygen** is removed by (1) ion-exchange resins (2) hydrogen (3)

## Here's analysis of primary loop at startup




**OPERATING CONDITIONS** at startup have important bearing on treatment. Hydrogen scavenges oxygen from system, raises pH by reacting with nitrogen to form ammonia

hydrazine. In a conventional steam boiler oxygen is removed by adding sodium sulfite which combines with oxygen to form sulfate. But this method is impractical since these ions are not tolerable in the primary loop. The same result is achieved, however, by using an anion-exchange resin in sulfite form. This unit is placed downstream from the mixed bed and used only for treating makeup to the primary and secondary water systems.

**Second approach** to oxygen removal is injecting gaseous hydrogen into the water downstream from the ion-exchange system. Excess hydrogen scavenges any free oxygen and represses oxygen formation by inhibiting dissociation of water. Excess hydrogen also reacts with free nitrogen to form ammonia and raise pH of system. At the same time this prevents synthesis of nitric acid from nitrogen. Curves, above, show the important contribution of hydrogen in regulating water conditions in the reactor. Minimum excess hydrogen concentration is 10 cc per kg of water. But it shouldn't exceed solubility of hydrogen in cold water at atmospheric pressure. In open swimming-pool reactors it's impossible to maintain enough dissolved hydrogen so oxygen residual is controlled by the use of sulfite exchange resin.

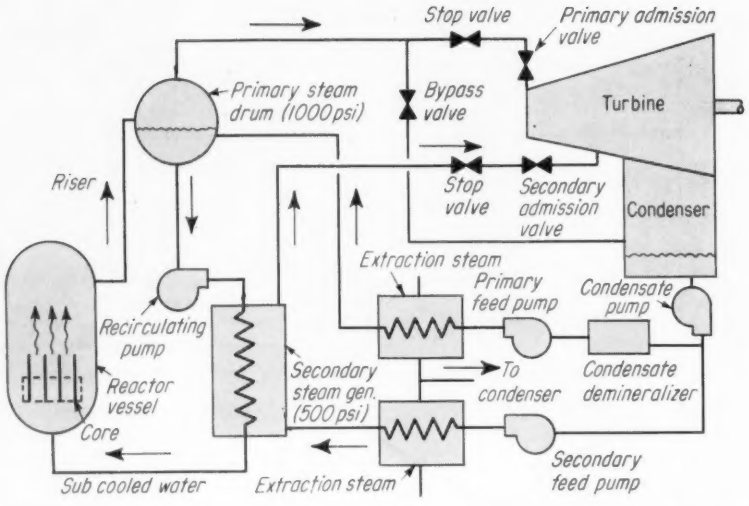
**Hydrazine,** the third method, is particularly useful in startup. Hydrogen and oxygen do not combine readily unless catalyzed in intense radiation. Since gamma radiation is low at startup, oxygen is scavenged by hydrazine during this period before it can react with metals in the system. Operating data on the APPR show that hydrazine reduced oxygen concentration from 5.4 cc per liter to zero over a period of 14 hours. Hydrazine was fed at the rate of 14 cc per min (0.04% solution) for a period of 4¾ hr.

**High-purity resins** are needed for reactor work. Nuclear-grade resins differ from standard types in three respects: (1) They are lower in leachable impurities (2) particle size is more uniform and (3) resins are converted as completely as possible into desired chemical form.

Resins are washed in alcohol to avoid possibility of introducing any organic materials. This leaches any residual organics trapped in interstices of resin beads during synthesis. Bead size is closely controlled to produce a narrow range of particle sizes. Not more than 0.3% of any batch pass through a 50-mesh screen. Maximum bead size is 0.45 mm for anion resin and 0.60 mm for cation resin. These size restrictions are designed to keep fines out of the system and provide minimum pressure drop without undue sacrifice of exchange capacity (which tends to decrease with increasing bead size).

Finally, special pains are taken to convert cation and anion resin as completely as possible into hydrogen, hydroxyl or other forms. Minimum of 95% of cation-exchange sites must be in hydrogen form. Minimum of 80% of anion-exchange sites must be in hydroxyl form with a maximum of 15% in carbonate form and 5% in chloride form. Capacity of mixed cation and anion resins is about 12 kgr per cu ft as $CaCO_3$, minimum.

**Abstract of ASME Chicago Section first-prize winning paper describes the heat cycle of world's largest boiling-water reactor plant now being built. Current limitation of medium-pressure saturated steam output raises special problems**




1 Dual-cycle boiling-water reactor generates steam at two pressure levels. Secondary steam generators use mixed primary-system drum water and feedwater as heat source

# Dresden nuclear power plant uses the dual boiling cycle

By FRANK A PALMER, Nuclear Thermal Engineer, Commonwealth Edison Company

The Dresden dual-cycle system has a reactor, four secondary steam generators, turbine, condenser, condensate pumps, primary demineralizers, primary and secondary feedwater pumps and primary and secondary feedwater heaters, Fig. 1. The station will have a net output of 180 mw at 2.5-in. Hg turbine backpressure.

The turbine gets its steam through two steam systems—primary and secondary. The reactor heats both steam supplies of the dual-cycle system.

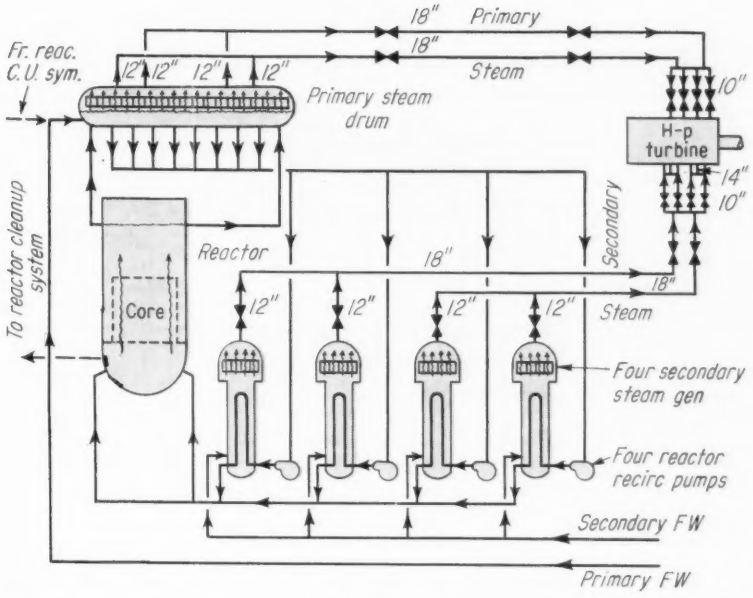
Heat generated in the reactor core transfers to the water flowing up through the core channels. Reactor recirculating pumps pass water through the reactor, steam drum and secondary steam generators at a top rate of about 25 million lb per hr. About 5% of the water circulating through the reactor evaporates to primary steam.

Steam-water mixture flows up to the primary-steam drum for steam separation. Steam at 965 psia flows to the first stage in the turbine. Saturated water mixes with the primary feedwater and leaves the drum at about 535 F through downcomers to enter the suction header of the four reactor recirculating pumps, Fig. 2.

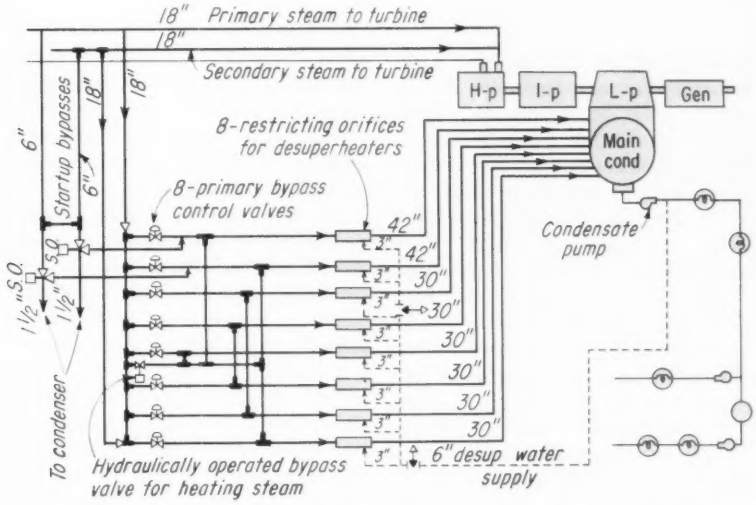
Each pump circulates the water through the tube side of one secondary steam generator. Secondary steam generated on the shell side flows to the 9th turbine stage. Four secondary control valves regulate the secondary steam flow to match the load. Since the recirculating rate stays constant, the secondary steam pressure varies with the steam flow rate. At zero flow the steam pressure essentially equals the reactor pressure, 990 psia. At 100% secondary steam flow totaling 1,180,000 lb per hr the pressure drops to about 475 psia.

The primary and secondary steam mix at the 9th turbine stage and flow through the turbine to the condenser. Steam bleeds from the turbine at five points for feedwater heating. Excess stage moisture leaves the turbine at three additional points.

The main condensate flows through the steam-jet air evactor and gland-steam condensers. At the gland-steam condenser outlet the condensate divides into two flows: one through the secondary feed pumps and feedwater heaters to the four steam generators;




**2** Primary steam released in single high-pressure drum of reactor flows to turbine at 965 psia. Secondary steam evaporated in four steam generators has variable pressure




**3** Bypass system leads steam to the desuperheaters and condenser during turbine warmup and after sudden loss of large load or after an emergency turbine-generator tripout

the other, through the condensate demineralizers, primary feed pumps and primary feedwater heaters to the primary steam drum.

**Main steam system.** The dual cycle, Fig. 2, uses two steam systems to remove as much heat as possible from the reactor with good stability and fuel economy. This is done by limiting the amount of boiling in the reactor and extracting additional heat from the water as secondary steam.

Position of the secondary control valves controls the turbine output. This changes the secondary steam flow. Since the water circulation through the reactor, primary drum and secondary steam generators stays constant, changes in the secondary steam flow vary the temperature of the water returning from the secondary steam generators to the reactor. This temperature variation changes the amount of subcooling and, consequently, the output of the reactor.

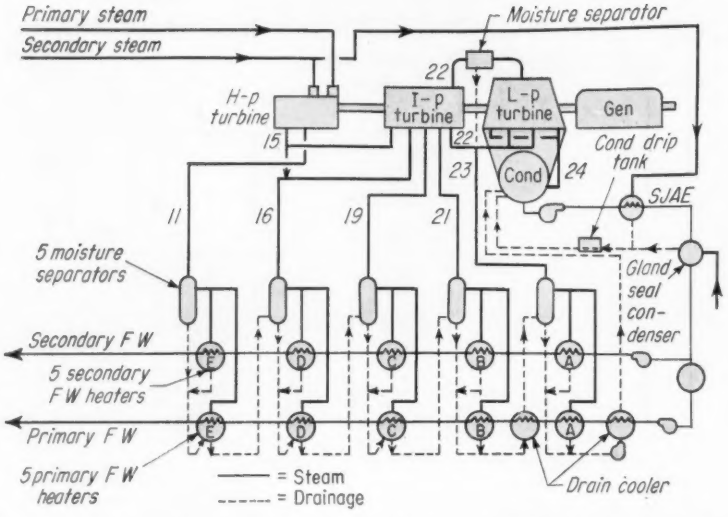
This method of operation changes the turbine output from 45 to 100% of full load by varying the secondary steam rate from 0 to 100% of its design flow. Primary steam flow varies slightly to maintain the primary system pressure as the reactor adjusts itself to the new power level. The load response is much faster than that of a conventional plant since the turbine runs at low temperatures and has less thermal stress during load changes.

**Bypass steam system,** Fig. 3, controls the pressure in the reactor and provides a path for the minimum steam flow before putting the turbine in service. When a sudden large load drop or turbine tripout raises the primary steam pressure, the bypass steam valves open and discharge the steam through a desuperheater to the condenser. (Throttling 965-psia saturated steam to 1.5-in.-Hg pressure would superheat it by 175 F.) The condensed steam is pumped back to the primary steam drum through the regular cycle. During normal operation, the primary control valves regulate primary steam pressure and the bypass valves remain closed.

The primary steam pressure will be held to ± 10 psi at the normal 965-psia operating pressure. This close tolerance must be held because a variation of pressure causes a variation in the quantity of steam voids inside the reactor. The steam voids directly affect reactor power output.

**Turbine extraction.** The saturated-steam supply causes more than the usual amount of moisture in the turbine stages. This requires using three moisture removal stages in addition to the five extraction stages for feedwater heating, Fig. 4. About 1% of the stage flow in the turbine is

**Two pressure levels of steam generation in the dual-cycle boiling-water reactor make it necessary to have two feedwater-heater lines**




**4** Primary and secondary systems each have their own set of feedwater heaters using common main turbine extraction points and moisture separators for heating steam

needed to produce the velocity for carrying out moisture particles.

The bled moisture and steam discharge to lower-pressure feedwater heaters or the condenser. The moisture removal decreases turbine efficiency about 1.5% while increasing stage efficiency a slight amount.

The two steam systems each have their own feedwater systems with their own set of five feedwater heaters. Steam extracted for feedwater heating flows to a moisture separator for each stage. Two steam lines leave each separator, each to supply one feedwater heater of the two systems.

Three higher-pressure heaters of the primary system have internal drain coolers and the two lower-pressure heaters have external drain coolers. Drainage from each separator tank and the corresponding feedwater heater flows through the drain-cooler section of the primary feedwater heater. The drainage from each primary drain cooler cascades to the moisture separator of the next lower stage heater. Drainage from the lowest-pressure drain cooler is pumped to the condenser.

**Demineralizers.** Condensate leaving the condenser has small amounts of suspended and dissolved solids from the turbine and condenser system and possible cooling-water leakage. Primary feedwater to the reactor must be of extremely high purity, so the full primary flow of 3100 gpm passes through two of three mixed-bed demineralizers before entering the primary feed pumps. The solids concentration leaving these beds will be a fraction of one ppm.

The third demineralizer acts as a spare while one of the other two is regenerated. When resins become too radioactive to regenerate economically, they can be flushed to a radioactive resin storage vault.

**Reactor cleanup system,** Fig. 5, removes corrosion-erosion products from the reactor water system to control purity in the recirculating loop. This system has two separate duplicate loops each with a capacity of 100,000 lb per hr. Booster pumps of each cleanup loop remove water from the suction header of the reactor recirculating pumps. Water flows from the booster pumps through a regenerative heat exchanger, a nonregenerative heat exchanger and a mixed-bed demineralizer. The demineralizer effluent flows back through the regenerative heat exchanger where it is preheated before discharging to the primary drum.

Heat exchangers cool the reactor water down to 120 F before it enters the demineralizing beds because these resins do not perform satisfactorily at higher temperatures. Only the heat given up in the nonregenerative heat exchanger is lost to the cycle.

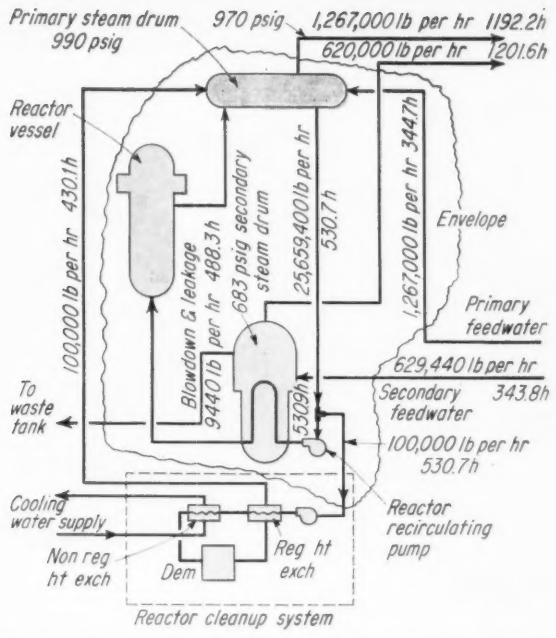
**Main condenser,** Fig. 6, has double tube sheets to detect leaks and reduce cooling-water leakage into the condensate system. The condenser tubes are standard phosphorized admiralty metal, 7/8-in. OD, 18 Bwg.

Each tube is rolled into both tube sheets and the space between tube sheets is filled with condensate. A leak in either tube sheet will change the condensate level and sound a low or high level alarm. A makeup tank automatically supplies condensate to the space as needed.

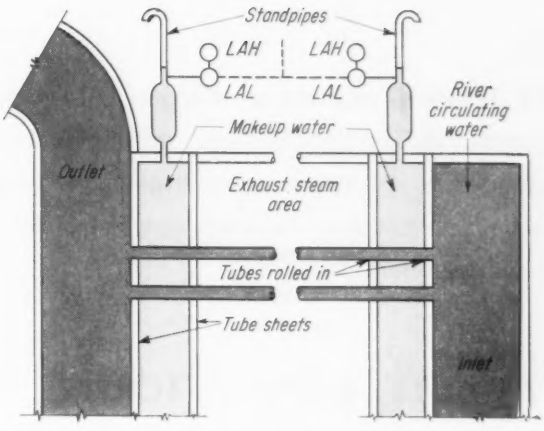
The condenser can handle full primary steam flow when the turbine trips out. Desuperheated primary steam from the bypass steam system enters the condenser through six 30-in.-dia pipes and two 42-in.-dia pipes. Maximum primary steam flow is about 1.4 million lb per hr.

The hotwell has enough volume for a 3-minute holdup of the condensate. This time reduces the short-lived radioactivity in the condensate to a negligible level before it leaves.

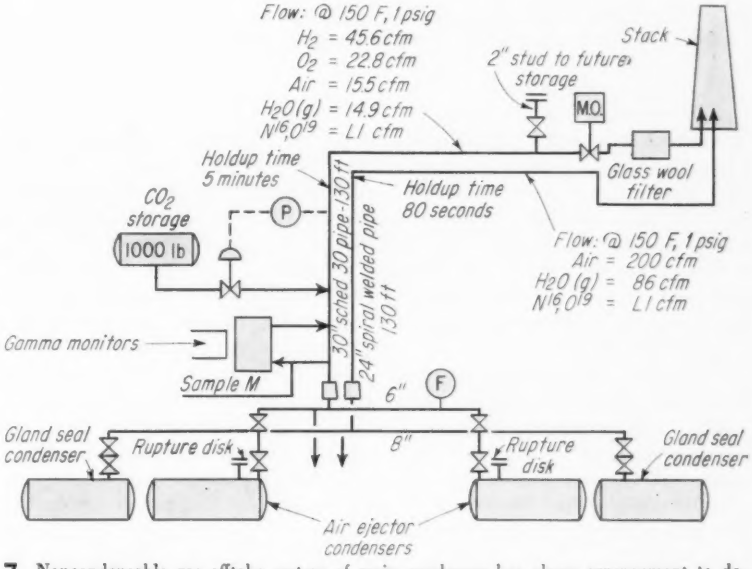
**Condenser off-gas system.** The




**5** Reactor cleanup system removes corrosion-erosion products from the reactor circulating-water system to control purity




**6** Double tube sheets in main condenser guard against mixing circulating water with main condensate returning to reactor




**7** Noncondensable gas offtake system of main condenser has alarm arrangement to detect excess reactivity that would be caused by failure of a fuel element in reactor

air ejectors, Fig. 7, withdraw noncondensable gases and air from the condenser. They handle about four times the volume of gases found in a conventional plant. These gases consist mainly of oxygen and hydrogen evolved in the reactor. Since these reactor gases are usually slightly radioactive, the evactor discharge is monitored continuously.

When fuel elements fail, fission product gases liberated from the fuel will sound an alarm in the 30-in.- dia discharge pipe so it can be isolated from the ventilation stack by closing the motor-operated valve in this line. The reactor would be shut down immediately. This 30-in. pipe is about 130 ft long and also provides a 5-minute delay for the decay of N-16 and O-19 to negligible radiation levels.

Oxygen and hydrogen in the off-gas system produce a hazard. The system is designed to contain explosions of this type. A $CO_2$ system connected to the holdup line automatically dilutes the discharged gases to less than 4% hydrogen (the lower explosive limit) on a rise in system pressure. The $CO_2$ system capacity will provide at least five min of dilution.

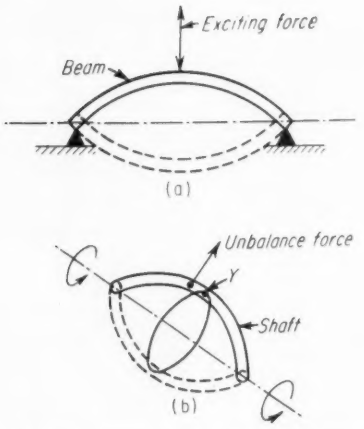
**Off-gas, gland seal condenser.** Steam seals all turbine glands to prevent steam leaking from the turbine or air leaking into the turbine. Excess steam from the turbine glands condenses in the gland seal condensers. A small motor-driven exhauster fan is used to draw noncondensable gases from these condensers.

The noncondensables consist primarily of radioactive nitrogen-16. The gases discharge into a 24-in.-dia pipe, 150 ft long, connected to the main ventilation stack. The piping has been sized for a holdup of 80 seconds for the decay of N-16 to a negligible radiation level. This holdup is separate from that of the air ejector system since explosive mixtures are not present.

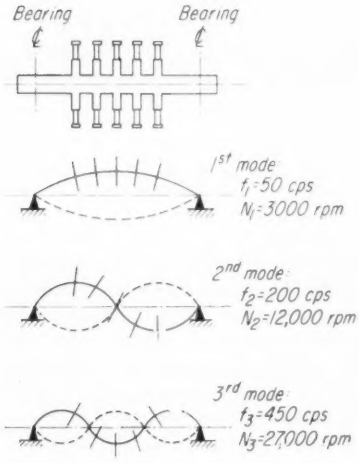
**All rotating machinery vibrates at resonant speeds. Builders make sure that their turbine speeds are predicted and controlled correctly to minimize vibration. To keep out of trouble and know your turbine here's . . .**

# What you should know about resonant speeds

By W J CARUSO, Vibration and Materials Engineer
Small Steam Turbine Dept, General Electric Company




**1** Static beams can be vibrated by exciting force, shafts by unbalanced force




**2** Turbine rotors have a series of resonant speeds with a rising frequency

A shaft rotating at a *resonant speed* vibrates at one of its natural frequencies. Rotating-shaft vibration differs from that of a stationary beam: (1) A beam supported at its ends must be excited by an external periodic force to make it vibrate. (2) The beam vibrates in a plane passing through its center line, Fig. 1*a*.

An exciting force working at one of the natural frequencies of the beam makes it vibrate in *resonance* with rather large amplitudes, even with a small exciting force. A rotating shaft also has natural frequencies, but it does not need an external exciting force to vibrate.

An actual shaft or rotor cannot be made perfectly concentric, symmetrical or homogeneous, so its center of mass will not lie on the geometric shaft center line. Distance between the center line and the center of mass is the *eccentricity*. As the shaft rotates the eccentricity produces a centrifugal force: $F = 0.0196\ Me(\text{rpm})^2$, where $M$ is the rotor mass, $e$ the eccentricity and rpm the shaft speed. $F$ acts as an exciting force and, since it turns with the shaft, its frequency equals the shaft speed. At a resonance the exciting-force frequency coincides with a natural frequency of the shaft—this is what we call a resonant speed.

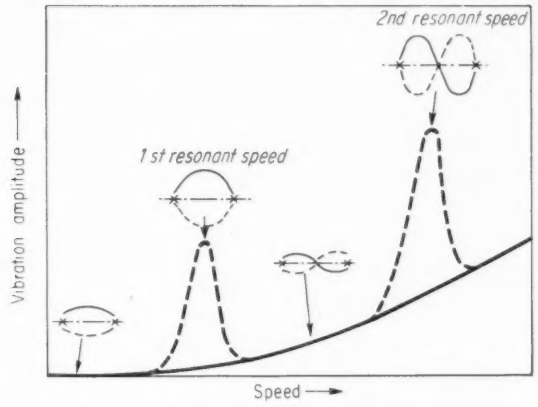
**Mode shapes.** The exciting force or *residual unbalance* rotates with the shaft. This makes the shaft bend and whirl about the center line between the bearings. For bearings equally stiff in all radial directions, the whirling will be symmetrical. That is, a point $Y$ on the shaft will describe a perfect circle about the center line of the rotor shaft, Fig. 1*b*.

Projecting the whirling motion on an axial plane gives a picture of the mode shape for the critical speed. An observer standing to one side of the whirling shaft sees it vibrate up and down in a vertical plane just like a stationary beam. The shape in which the shaft deflects at any instant is the *mode shape*.

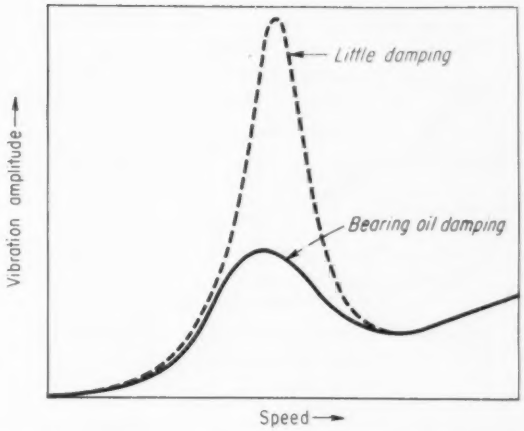
A rotor has a great many natural frequencies or resonant speeds. Fig. 2 shows a uniform shaft with five turbine wheels and the first three modes and shapes it will assume at its natural frequencies. The shapes are grossly exaggerated.

In the first mode, Fig. 2, a given unbalance would cause a larger vibration if it were exactly at mid span, where the amplitude is largest, than if it were closer to one of the bearings. But, in the second mode, an unbalance at mid span would cause no vibration since it is at a *node*, point of zero amplitude. The *sensitivity* or tendency of a shaft to vibrate with large amplitudes from unbalance will depend on the resonant speeds, mode shapes and unbalance locations, and other factors.

**Vibration response.** Design approach to resonant speeds can be to (1) avoid operation at resonant speed or (2) keep vibration amplitudes small if the rotor must run at or through resonant speeds. Residual unbalance will make a rotor vibrate at all speeds, vibration increasing




**3** Shaft-vibration amplitude rises with rotating speed. At resonant speeds amplitude rises and falls sharply, changes modes




**4** Vibration amplitude depends on more factors than the unbalanced force; the bearing oil can reduce it at resonant speed

with the square of the speed. Vibration amplitudes will also vary with speed and exciting force, as the solid curve in Fig. 3.

For a particular rotor the vibration response level depends only on the magnitude and location of the residual unbalance. At a resonant speed the vibration response curve may peak, dashed curves, Fig. 3. This means the rotor will be more sensitive to unbalance at resonant speeds. If possible, rotors may be designed so resonant speeds fall outside the operating range. The small sketches, Fig. 3, show how mode shape changes with speed.

Vibration response peaks depend on the amount and location of residual unbalance and also on the mode shape and amount of damping in the system. The response will not be infinite at resonant speeds—it will always be limited by the damping, particularly in the bearing-oil films. Proper design and manufacture flatten out the response peaks so the rotor can run through its resonant speeds with comparatively small vibration amplitudes.

**Reducing vibration.** To reduce rotor vibration we can (1) decrease the sensitivity to unbalance (2) avoid running at resonant speeds (3) provide sufficient damping (4) reduce the residual unbalance. Because of limited space we'll concentrate on more important items (1) and (2).

An excessively vibrating turbine may cause connecting pipes, valves and plates to vibrate and rattle. Amplitudes may be large enough so the vibration can be seen, and may be especially noisy at certain frequencies. These external effects do not detract from the basic duty of the turbine, except that fatigue failures could occur in piping or other structures. But this is not likely.

Excessive vibration may increase wear on bearings and make them fail. It can also increase wear of flexible couplings, cause rubbing of packings or deflectors and raise the shaft stresses. Usual clearances avoid rubs between rotating and stationary parts. Shaft-bending stresses from rotor vibration are much lower than those that would cause failure. Most likely, excessive rotor vibration would increase maintenance of bearings and couplings. A large amount of vibration can be tolerated without suffering serious damage, but every effort should be made to reduce vibration.

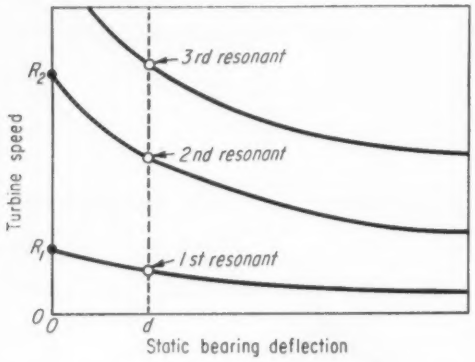
**Unbalance sensitivity.** Rotor design based on unbalance sensitivity must consider (1) location of resonant speeds (2) deflection shape of vibrating rotor (3) amount of damping in system.

Beneficial effects of damping are evident only when the turbine runs at a resonant speed, Fig. 4. Without damping we have a narrow sharp response curve. But conventional cylindrical sleeve bearings have enough damping in the oil film to limit the vibration peak to lower level.

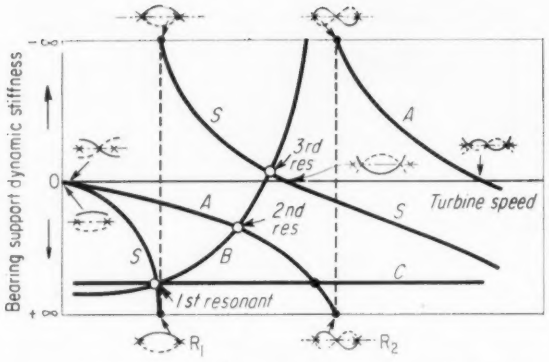
Theoretically, a perfectly balanced rotor would not vibrate, even at resonant speeds. A slight unbalance, however, could cause large vibration amplitudes if the rotor is sensitive to unbalance. Conversely, a rotor insensitive to unbalance will experience very little change in vibration amplitude despite large variations in unbalance. Any unbalance from deposits, corrosion, misalignment would have very little effect on the vibration and so the need for periodic rebalancing would be minimized.

Rotors can be designed to be less sensitive to unbalance. Analyses of vibration mode shapes help take full advantage of relationship between rotor weight and shaft stiffness. Such studies determine: (1) Locations where shaft should be stiffest. (2) If shaft overhangs should be reduced or supported by an additional bearing. (3) Shaft dimensions for particular weight distributions or concentrations of wheels, couplings and other components. (4) Locations needing weight reductions. In addition, the studies show when more careful manufacturing, balancing and assembly methods must be used.

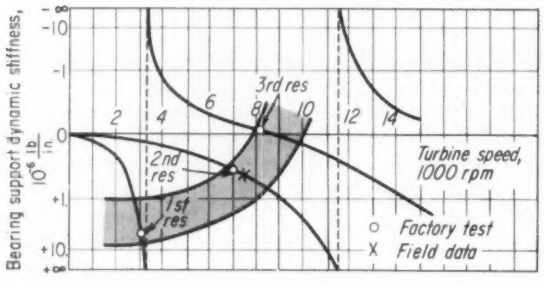
**Predicting resonant speeds.** We must still try to avoid operating at the second and higher resonant speeds despite progress in decreasing balance sensitivity. Turbine resonant speeds depend on characteristics of the bearing supports as well as the geometry of the rotor. To predict resonant speeds accurately we must know bearing support stiffness, dynamic effects of bearing oil film and




**5** Bearing deflections reduce resonant speeds to a lower level than predicted on the basis of rigid shaft-bearing supports




**6** Dynamic stiffness method is more accurate in predicting series of resonant speeds in shaft, allows for bearing flexibility




**7** Comparison of calculated resonant speeds with actual speeds of shaft shows basic soundness of dynamic stiffness method

nonrotating masses and stiffness. Failure to take these factors into account makes our predicted resonant speeds higher than actual speeds.

The static bearing deflection concept introduces equivalent bearing flexibilities in the calculations. It assumes that the rotor weight produces static deflections at the bearing supports as a weight deflects a spring. Resonant speeds are calculated assuming different static bearing deflections from zero to several thousandths of an inch. Fig. 5 shows typical curves for the first three resonant speeds versus static bearing deflection of a rotor.

At zero deflection, $R_1$ and $R_2$ are the 1st and 2nd resonant speeds for rigidly supported bearings. For a deflection $d$ the predicted resonant speeds are lower. From resonant speeds of running turbines, $d$ was established for turbines of various sizes.

This method does not account for changes in bearing stiffness with rising speed. This makes predicted second resonant speeds higher than actually found in operation.

**Dynamic stiffness.** We developed the *dynamic stiffness* method of predicting resonant speeds about two years ago. It accounts for all the rotating and stationary masses and stiffnesses that make up a complete turbine, and allows for the change in stiffness with speed.

For analysis, the turbine is split at the bearings into two sub-systems; the rotor system and bearing support system. By analyzing them separately we get a better understanding of their interaction.

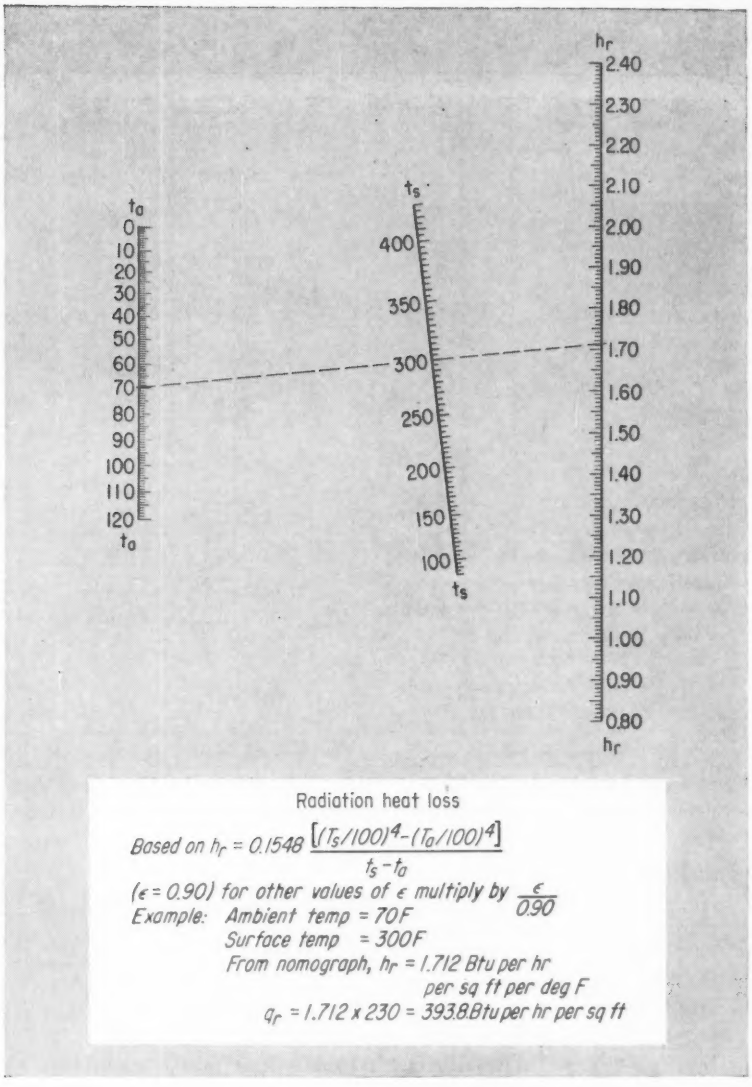
Fig. 6 shows calculated rotor stiffness curves. The ordinate has a scale centered on zero and going to plus and minus infinity. It includes the entire range on one graph. The abscissa is an arithmetic scale of turbine speed. Two sets of curves start at the origin: the $S$ curves are a series of resonant speeds with symmetric mode shapes, the $A$ curves are a series of resonant speeds with antisymmetric mode shapes. These curves include all the possible shapes for a 2-bearing rotor. They show how the mode shape changes gradually with dynamic stiffness, see the auxiliary sketches.

Rigid-bearing 1st and 2nd resonant speeds $R_1$ and $R_2$ develop at infinite bearing stiffness. At very low speeds the 1st resonant mode shape degenerates to a "bouncing" motion while 2nd resonant is a "rocking" motion.

The $B$ curve, Fig. 6, shows the support-system dynamic stiffness variation with turbine speed. Each intersection of $B$ with $A$ or $S$ shows an actual resonant speed of the complete rotor-support system. They show three in Fig. 6.

For comparison, the $C$ curve shows the static bearing deflection concept. Both methods predict the same first resonant speed, but differ completely on the second resonant speed.

Resonant speed data have been obtained for a number of turbines and correlated with predictions. Fig. 7 shows the acceptable correlations obtained. The shaded band shows the expected range of dynamic stiffness for the support system. The points show the actual resonant speeds. This method has proved itself to be accurate and very useful in m-d turbines.




## LEGEND

**SYMBOLS**

- $h$ = Heat transfer coefficient, Btu per hr per sq ft per deg F
- $t$ = Temperature, F
- $T$ = Absolute temp, R or F + 459.7
- $T_f = \frac{T_s + T_a}{2}$ (film temperature, R)
- $\Delta t$ = Temperature difference, F or R
- $q$ = Heat transfer rate, Btu per hr per sq ft of surface
- $q'$ = Heat transfer rate for pipe, Btu per hr per linear ft
- $e$ = Emissivity
- $v$ = Air velocity, ft per sec
- $D, d$ = Diameter, in. (when both are used, $D$ is the larger and $d$ the smaller of two diameters). For special case see Equation 2 and its explanation in text
- $D_o$ = Outside diameter, in.
- $k$ = Thermal conductivity coefficient, Btu per hr per sq ft per deg F per in. thickness
- $x$ = Insulation thickness, in.

**SUBSCRIPTS**

- $i$ = Inside
- $a$ = Ambient
- $s$ = Surface
- $m$ = Mean
- $r$ = Radiation
- $c$ = Convection

1 Nomograph's heat-transfer coefficients simplify surface heat-loss calculations

**Insulating hot surfaces can pose knotty problems. Here's the first of a 3-part series giving graphical aids to . . .**

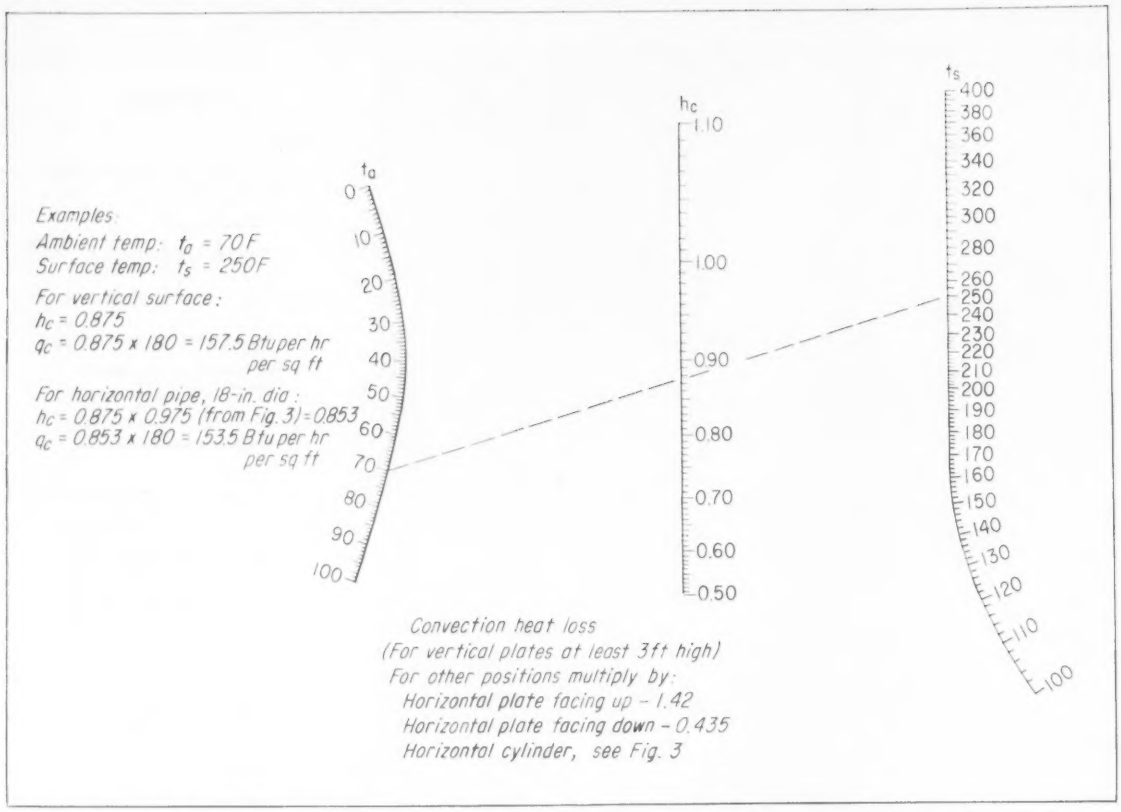
# Simplify heat-loss calculations

By C R KISE, PE, Baldwin-Hill Co, Trenton, N. J.

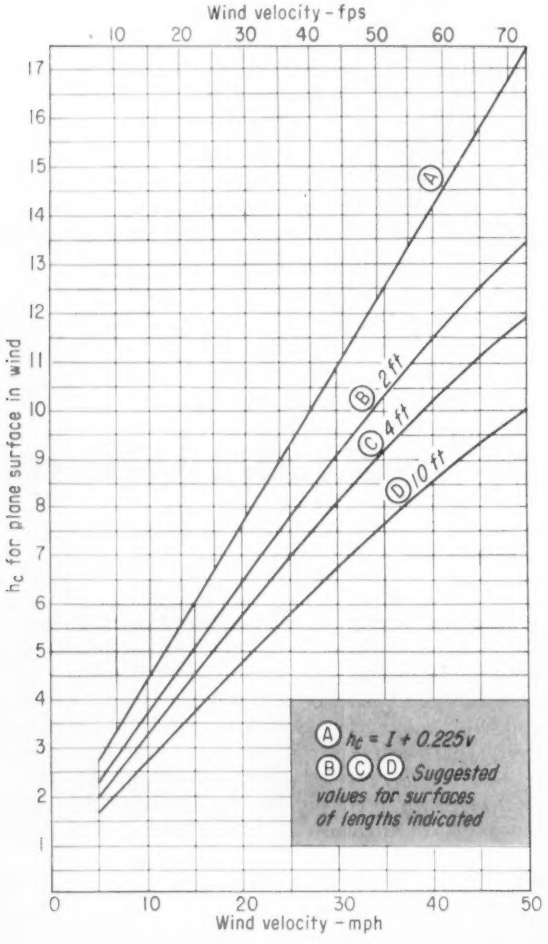
Calculating heat transfer through insulation is an easy task when both hot- and cold-surface temperatures are known. But the temperature of the cooler external surface usually is unknown; a condition tending to complicate life for the designer. He must assume values for this surface, calculate heat transmission through the insulation and then balance this against the heat loss from the surface.

This isn't as simple as it sounds. It involves tedious cut-and-try calculations and solution of complex formulas in which accuracy is a laborious process. To avoid this, there is, perhaps, a tendency to use generalized curves or rules-of-thumb. These are suitable for rough approximations but aren't accurate enough where ambient conditions and surface emissivity must be calculated closely; particularly if surface types (flat or curved) and their orientation (horizontal or vertical) differ.

Solving such problems can be simplified by using nomographs or alignment charts and curves. With these,


Examples:
Ambient temp: $t_a$ = 70 F
Surface temp: $t_s$ = 250 F
For vertical surface:
$h_c$ = 0.875
$q_c$ = 0.875 x 180 = 157.5 Btu per hr per sq ft
For horizontal pipe, 18-in. dia:
$h_c$ = 0.875 x 0.975 (from Fig. 3) = 0.853
$q_c$ = 0.853 x 180 = 153.5 Btu per hr per sq ft
$t_a$
$h_c$
$t_s$
Convection heat loss
(For vertical plates at least 3 ft high)
For other positions multiply by:
Horizontal plate facing up – 1.42
Horizontal plate facing down – 0.435
Horizontal cylinder, see Fig. 3

**2** Published correlated test data and graphic presentation of the relationship between variables involved in natural convection form the basis for this nomograph. It gives heat-transfer coefficients for vertical surfaces and correction factors for horizontal


Wind velocity – fps
$h_c$ for plane surface in wind
Wind velocity – mph
A
B 2 ft
C 4 ft
D 10 ft
A $h_c = I + 0.225v$
B C D Suggested values for surfaces of lengths indicated

simple slide-rule calculations can solve specific problems with a respectable degree of accuracy where both surface temperature and ambient conditions are known.

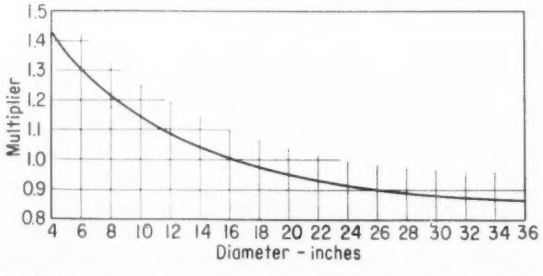
First, let's discuss heat loss from hot surfaces. In future months we'll deal with insulated surfaces and the problem of determining surface temperature.

A hot surface transmits heat to the atmosphere by radiation and convection. Factors combining the two heat losses are so limited in use that any pretense of accuracy requires that the two be treated separately.

**Radiation.** Commonly accepted formula is:

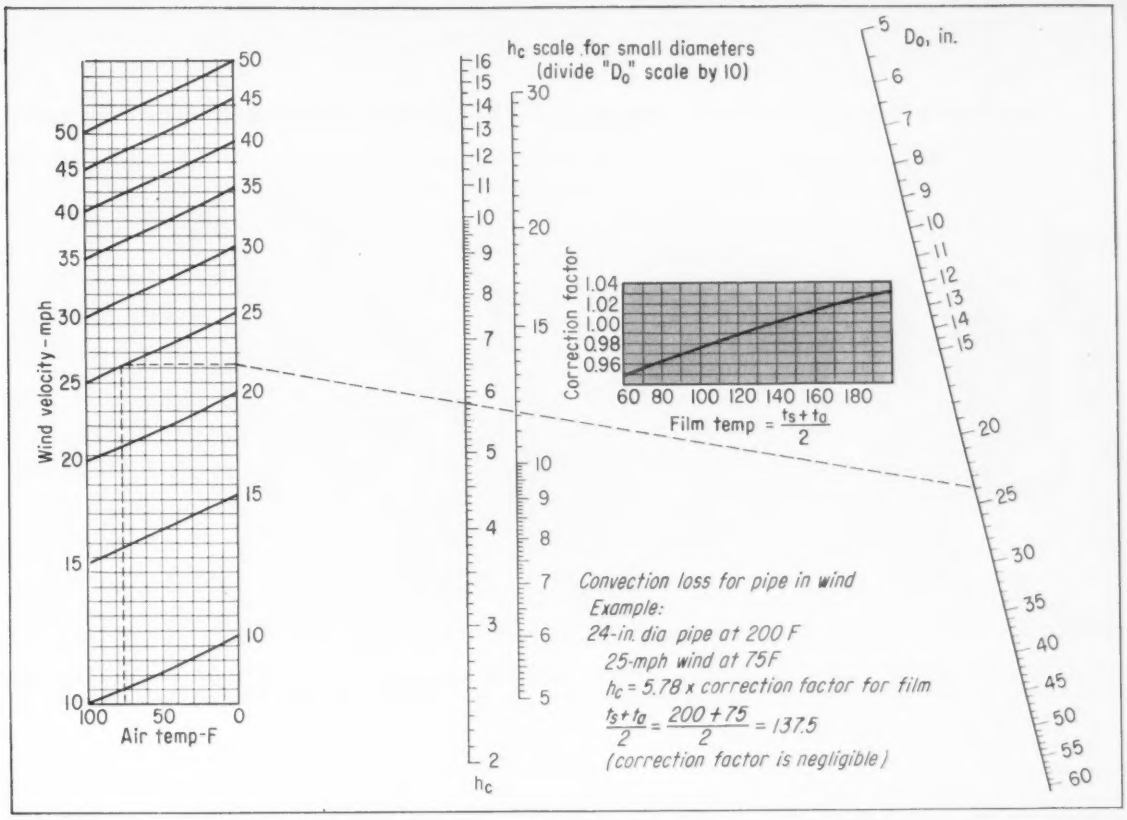
$$q_r = 0.172\, e \left[ \left( \frac{T_s}{100} \right)^4 - \left( \frac{T_a}{100} \right)^4 \right]$$

(See table, page 79, top right, for a definition of terms.)




**3** This curve giving multipliers for natural convection loss from horizontal cylinders should be used in conjunction with Fig. 2

**4** Plane surfaces exposed to wind are subject to highly variable heat losses. Curves give suggested heat-transfer coefficients


Wind velocity - mph
Air temp-F
$h_c$ scale for small diameters
(divide "$D_o$" scale by 10)
$h_c$
Correction factor
Film temp = $\frac{t_s + t_a}{2}$
$D_o$, in.
Convection loss for pipe in wind
Example:
24-in. dia pipe at 200 F
25-mph wind at 75F
$h_c$ = 5.78 x correction factor for film
$\frac{t_s + t_a}{2} = \frac{200 + 75}{2} = 137.5$
(correction factor is negligible)

**5** Pipe and other cylindrical surfaces exposed to air currents pose knotty heat-loss problems. These charts, based on correlation of data supplied by many investigators (and extrapolated for higher Reynolds' numbers) can greatly simplify related problems

If we divide this formula by $(t_s - t_a)$ we have it in suitable form for constructing an alignment chart giving Btu per hr per sq ft per degree temperature difference between the surface and its surroundings.

Fig. 1 is so constructed. To use it connect points for ambient and surface temperatures with a straight edge and read heat-transfer coefficient $(h_r)$. Surface radiation loss $(q_r)$ then equals $h_r(t_s - t_a)$. Chart is based on a surface having $e = 0.90$, a satisfactory value for bare steel or dark paint on metal. For other emissivities, multiply by ratio of actual emissivity to 0.90, that is: $h_r \times e/0.90$.

**Natural convection.** For hot surfaces *in still air*, McAdams (*Heat Transmission*, 3rd ed, 1954, McGraw-Hill Book Co) has correlated test data and shows graphically the relationship between variables involved. This correlation is the basis for Fig. 2 which gives heat-transfer coefficient $(h_c)$ directly for vertical surfaces at least 3-ft high. Correction factors are given for horizontal surfaces. For horizontal cylinders, Fig. 3, which gives correction factors for diameter, should be used in conjunction with Fig. 2. For those who would like an equation for Fig. 2, the following is in good agreement with the McAdams correlation over the range covered by the charts:

$$h_c = 19.14 \left( \frac{\Delta t^{0.3}}{D^{0.22} T_f^{0.6}} \right)$$

Here $D$ is vertical surface height, horizontal plate breadth, or pipe or other cylinder diameter in inches. Since size effect is comparatively slight for lengths over 3 ft, a simplified formula can be used for these larger surfaces:

$$h_c = 8.7 \left( \frac{\Delta t^{0.3}}{T_f^{0.6}} \right)$$

These multipliers or correction factors can be used with either equation: Vertical surface, 1.00; horizontal surface facing up, 1.42; facing down, 0.435; horizontal cylinder, 0.87.

**Forced convection.** Wind-exposed objects are subject to much higher heat losses. There are many variables, experimentation is difficult and there are no universally accepted formulas. For flat surfaces, this formula has long been used and is plotted as Curve A in Fig. 4:

$$h_c = 1 + 0.225v$$

Curves B, C and D are suggested approximate values of $h_c$ for air temperatures between 0 and 90 F, and are based on ASHVE research data indicating that lower values of $h_c$ may be more accurate, particularly for long surfaces.

Pipe and other cylindrical surfaces exposed to wind or air currents are a knottier problem. No one formula or simple relationship covers a wide range of conditions. McAdams has correlated data from many investigators covering heat loss for single cylinders with air flow at right angles. Fig. 5, based on this correlation (extrapolated for higher Reynolds' numbers), simplifies estimates.

Using Fig. 1 for radiation loss and appropriate selection from Fig. 2 to 5 for convection loss, one can now find heat loss from any common type of surface of known temperature. Next month we'll give some examples which may be helpful in explaining use of the diagrams.

**Because silicon rectifiers are mechanically**

**POWER SILICON CELLS** are hermetically sealed in stainless steel. Hefty mounting stud is used to remove heat from junction. Air-cooled cells are rated up to 400 amp

# Here's what silicon-rectifier ratings mean

## Successful application of silicon rectifiers requires an understanding of the basis for manufacturers' rating of the cells

By D K BISSON, General Electric Company, Clyde, N. Y.

Silicon power rectifiers are practical devices which offer many advantages over other types of rectifiers. (Refer to POWER, July 1957, pp 73-76 and November 1958, pp 82-85.) However, they have some characteristics which differ from the more conventional rectifiers. The keys to successful application of silicon rectifier cells are: (1) a firm knowledge of the electrical characteristics of the cells and (2) an understanding of how the ratings are determined from these characteristics.

Let's take a look at a particular cell that's typical for power applications—the General Electric Type 4JA60, photo, above. This cell is about 1½ inches in diameter and 4½ inches long including a 3-inch flexible lead. It has a copper cooling stud with ¼-18 pipe thread for attaching it to a heat sink.

Rating limitations of this cell are primarily thermal. Since conduction through the cell is accompanied by a voltage drop, and blocking is accompanied by leakage current, the operating power loss causes the junction temperature to rise above the ambient. Determination of power loss and internal thermal characteristics of the rectifier cell are, therefore, our main concern.

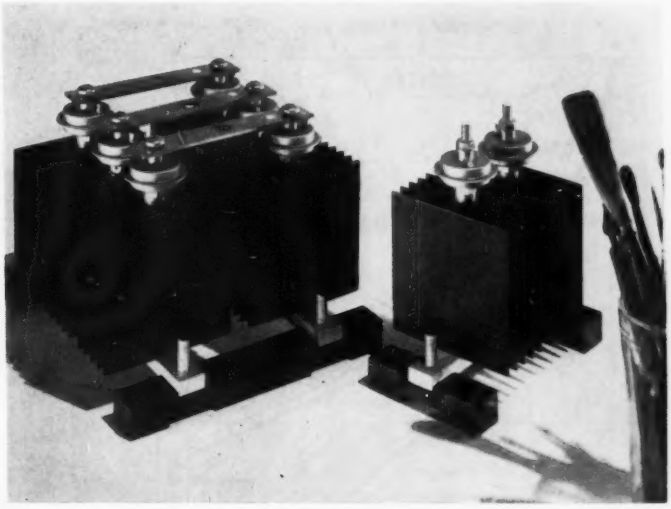
**Junction temperature limit** of 200 C maximum has been established for the 4JA60 cell on the basis of (1) deterioration rate of the blocking characteristic (2) magnitude of leakage current and (3) melting point of the materials used in the cell.

The conduction characteristic does not change with time, but the blocking characteristic does above a certain temperature. This has been GE's experience with all silicon and germanium cells. This change is believed to result from increased surface leakage caused by contamination which becomes active when the safe temperature is exceeded. This is taken into account.

**Conduction power loss** causes internal heating. The shape of the forward *E-I* curve, Fig. 1, has been verified

## rugged and easily mounted they offer many application possibilities

**COMMUTATOR** is replaced by silicon-rectifier cells in special-purpose direct-current generator



**RECTIFIER STACKS** consist of cells and fin radiators. Cells are available in two polarities to simplify mounting. Ac connections are at top, dc at bottom

by measurements on a number of cells. At currents less than one ampere, voltage drop was measured with direct current flowing continuously. This method isn't satisfactory for higher current levels because internal heating causes the junction temperature to change. Therefore high-current measurements were made using a pulse technique, in order that the temperature of the case and that of the junction could be assumed to be identical, and the required accuracy obtained.

For application purposes the forward *E-I* curve can be represented by the following equation in the range of 0.1 to 1000 amperes:

$$e = 1.18 - T/5800\ ln\ k/i + iR \qquad (1)$$

where $T$ = junction temperature in degrees Kelvin, $k$ = device constant of 7500 amp, $i$ = instantaneous forward amp, $e$ = instantaneous drop in volts, $R$ = device constant of 0.00145 ohms at 200 C, and $ln$ = the natural logarithm.

The resistance $R$ is not perfectly linear, but appears to decrease with increasing current. The crossover of the curve (Fig. 1) results from the negative temperature dependence of the second term of the equation and the positive temperature dependence of the resistive term. Because of the nonlinearity of the conduction characteristic, it's not correct to assume conduction power loss varies directly with the average or rms cell current. True junction power loss is between these extremes.

Conduction loss for any wave shape of any magnitude can be determined from equation (1). If the current wave form can be expressed as an equation, the product of the current equation and equation (1) can be integrated between the appropriate limits. Curves of Fig. 2 were derived in this manner for circuits energized by a sine wave connected to a resistive load. For an example, let's consider the case of a single-phase rectifier unit:

$$i = I_m\ sin\ wt, \text{ between limits 0 and } \pi \qquad (2)$$

Multiplying equations (1) and (2), and integrating:

$$P = \frac{1}{2\pi}\int_0^{\pi}\left[I_m \sin wt\right]\left[1.18 - \frac{T}{5800}\ ln\ \frac{k}{I_m \sin wt} + Im\,R \sin wt\right] dwt \qquad (3)$$

$$P = I_m\ (0.37 - 0.025\ ln\ k/I_m + 0.25\ I_m R) \qquad (4)$$

Graphical integration is also satisfactory.

Although curves of Fig. 2 were derived for resistive loads, they are applicable to inductive loads. Latter tend to make cell losses slightly less because of a more favorable peak-to-average ratio. Circuit commutation also reduces cell loss.

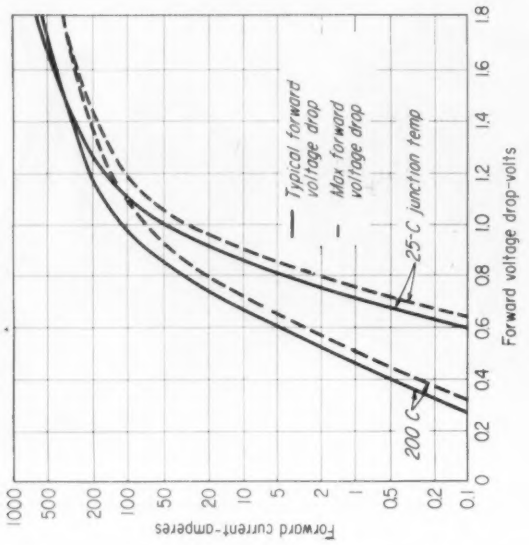
**Blocking power loss** is caused by leakage current. Blocking characteristics of the 4JA60 cell on an instantaneous basis at 200 C are shown in Fig. 5. The leakage current varies exponentially with temperature in the region of 200 C. At room temperature the results are not easily predicted because of a high percentage of surface leakage current in comparison with the expected bulk leakage current.

With silicon rectifiers the reverse power loss is usually a small part of total power loss and is often neglected in determining cooling system requirements. It is highly significant in determining the piv rating, however, as it has a direct bearing on thermal stability. If the change in conduction power loss with temperature is neglected it can be shown that thermal runaway is a function of two variables, reverse power loss and thermal impedance:

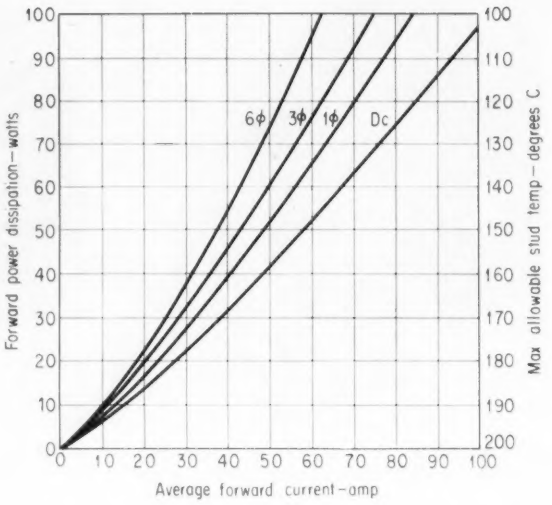
$$P_r = P_o\, e^{\delta \Delta T} \ (5) \quad P_g = P_r + P_f \ (6) \quad P_d = \Delta T/K \ (7)$$

where $P_r$ = reverse heating at junction temperature $T_j$, $P_o$ = reverse heating at ambient temperature $T_a$, $\Delta T$ =

## Forward-current characteristics of a cell play an important role




**1** Instantaneous forward voltage-drop curves at typical and maximum conditions are shown above for 25-C and 200-C junctions




**2** Power dissipation and maximum allowable stud temperature as they relate to average forward current in typical rectifiers

$(T_j - T_a)$ in degrees C, $e$ = natural log base, $\delta$ = constant of temperature variation, $P_g$ = total heat generated in watts, $P_f$ = forward heat generated, $P_d$ = total heat dissipated to ambient, $K$ = thermal impedance from junction to ambient in degrees C per watt.

Substituting equations (5) and (6):

$$P_g = P_o e^{\delta \Delta T} + P_f \qquad (8)$$

Stable operation occurs at the intersection of the locus of the heat generation and dissipation equations. Instability occurs when the two curves don't intersect. Maximum power level occurs when the curves are tangent. By mathematical analysis it is shown:

$$P_{g\ max} = P_f + 1/\delta K \qquad (9)$$

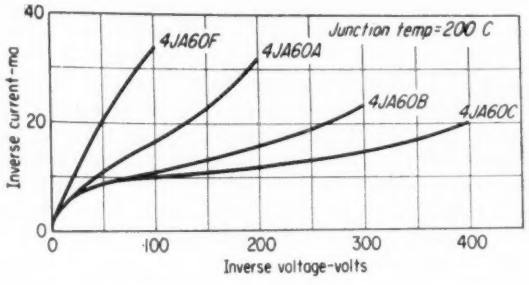
Since it is assumed that forward power is independent of temperature, the runaway point is determined by reverse power alone, therefore:

$$P_{r\ max} = 1/\delta K \qquad (10)$$

Leakage current limit for each piv classification grade has been set with a liberal safety factor for deterioration of reverse characteristics which might take place in operation. This value of piv is the maximum continuous rated piv and has values of 50, 100, 200 and 300 volts for the types (left to right) represented in Fig. 5.

**Temperature rise** above an external cooling system depends directly on steady state power loss. Knowing the power loss and the internal thermal impedance of the cell, the internal temperature rise of the junction can be found. A reference point has been provided on the 4JA60 cell in the form of a thermocouple hole on the hex of the cooling stud, photo p 82. Thermal impedance values from the junction to the reference point and to the stud threads are given by the manufacturer.

After the power loss for the cell has been determined for a particular application, the size of the fin required to do the job is either calculated or taken directly from a curve such as given in either Fig. 3 or 4.

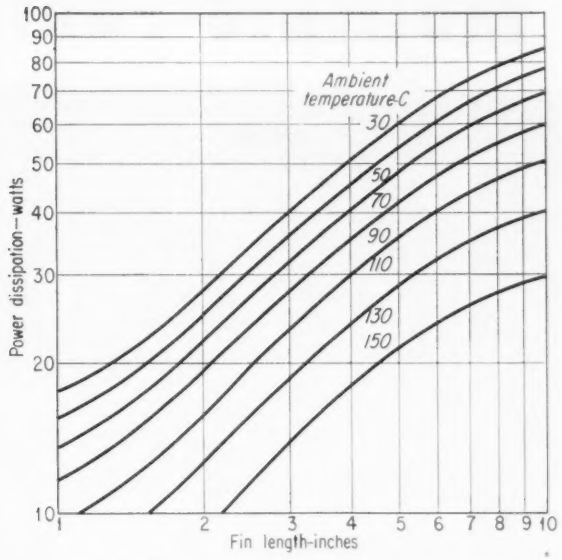



**5** Inverse leakage current on instantaneous basis compared for four typical silicon cells at a junction temperature of 200 C

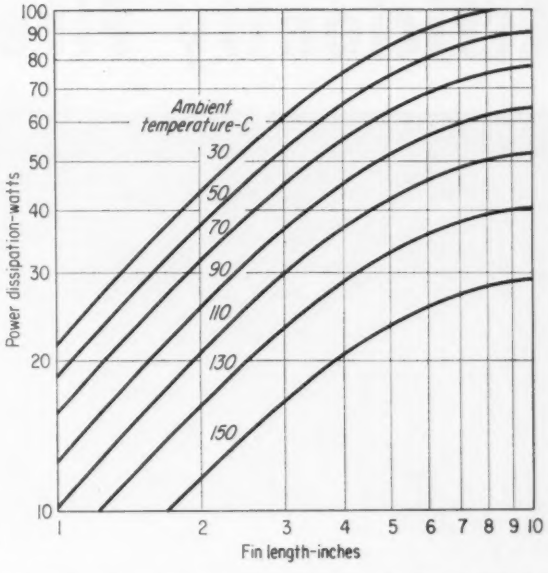
**Transient ratings** are important. Although the junction temperature does not increase instantaneously, the time constants involved are very short. As a result of the low thermal capacity of the cell, overloads of more than 15 or 20 seconds must be considered as steady state as regards internal temperature.

**Surge-current curves** are illustrated by Fig. 6 which relates allowable overload current to time on a 60-cycle basis. These curves are based on experimental data taken with the cells operating at their maximum rated conditions both before and after the surge. Greater currents can be handled for intervals of less than one-

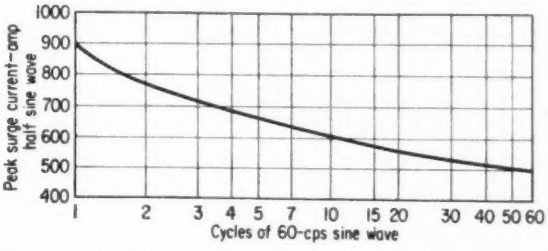
## Air cooling by fins is adequate for most silicon rectifiers




**3** Air cooling provided by a single fin with unimpeded radiation can be determined from cooling curves similar to those above




**4** Forced air cooling with air velocity over the fins of 2000 feet per minute can remove heat as indicated in typical curves




**6** Maximum allowable surge current at the maximum rated load conditions is an important limitation on silicon rectifier uses

half cycle such as might be encountered when current-limiting fuses are used for the protection of the cell.

The ideal application from a reliability standpoint would be one with an unvarying load. Wide temperature fluctuations with the widely differing temperature coefficients of the materials making up the cell could possibly cause thermal fatigue and cell failure. With applications of varying load it's desirable to have sufficient mass in the cooling element to minimize the temperature excursions. Likewise, the minimum possible junction temperature should always be used to limit the magnitude of junction temperature excursions.

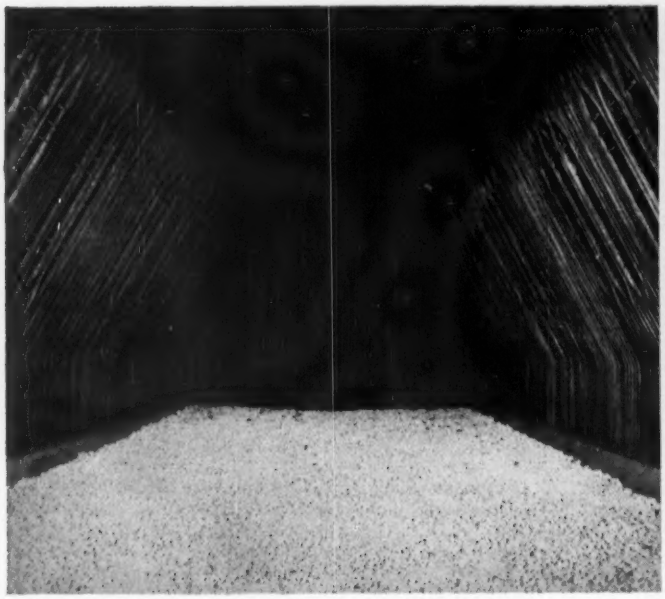
**Surge voltage** imposes limitations. The operating piv of a silicon rectifier cell may be limited by an abrupt voltage breakdown characteristic or by thermal runaway. Two piv ratings are usually provided. One is the continuous rating while the other is an overvoltage rating of 100 volts more than the continuous value. (It is 50 volts more for the 50-volt cell.) These overvoltages are those which may be sustained for times in the order of five milliseconds. Sufficient safety factor is included in the continuous rating to insure stable operation regardless of load or heat sink provided that steady-state junction temperature doesn't exceed the 200-C mark.

From equation (10) you can see that the maximum reverse power allowable without causing thermal runaway is inversely proportional to thermal impedance. As a result of the thermal capacity of the cell effectively lowering the thermal impedance to pulses of short duration, it can be assumed that the normal reverse power loss can be exceeded for short times without reducing the thermal runaway safety factor.

**Series and parallel** operation are frequently required for power applications. Voltage and current sharing can be achieved in multiple-cell circuits through the use of resistors. Experience has shown that this is not mandatory where factory-matched cells are used. Although some voltage unbalance will exist cells may be used in series without voltage derating. When three or more cells are used in series it may be necessary to use shunt capacitors to insure voltage division under transient conditions. Expected higher-voltage cell ratings will reduce the need for series combinations.

The average current rating of parallel-operated cells should be derated by 10% to allow for variations between the matched cells. The characteristics are matched at both high and low levels to insure proper current division on fault conditions as well as normal operation.

# Specially Designed RILEY Efficiently Fire Multiple Fuels



Inside the Turbo Furnace at Sterlington Steam Electric Station of Louisiana Power and Light Co. Overall width 54'—7⅞", depth 24'—0-3/16". No. 1 firebrick rubble covers the furnace floor. Twenty Riley Directional Flame Burners are arranged for opposed firing on front and rear walls. Burners are shop fabricated assemblies. Burner close-up shows directional vanes, two

*The Riley TURBO FURNACE unit is one of the major furnace design advances in recent years for the more efficient utilization of fuels. It is known as a multifuel unit primarily because of its ability to produce similar furnace exit gas temperatures with gas, oil, coal or other solid fuels. This phenomenum is due to the fact that natural gas, which ordinarily burns with a non-luminous flame, burns in a TURBO FURNACE with a luminous flame similar to oil and coal. In a TURBO FURNACE, fuels are burned with extremely high turbulence at the furnace bottom; in the case of pulverized coal, over a slag pool. Much of the unusual combustion efficiency is due to opposed firing with Riley Directional Flame Burners specially designed for firing multiple fuels singly or in combination. These fuels may be pulverized coal, oil, gas, or other special solid fuels such as fluid coke or lignite.*

### Water Cooled Burner

The Riley Directional Flame Burner is designed for opposed firing on one level. Each Riley Directional Flame Burner is installed as a unit complete with water cooling tubes which are welded to the waterwall circulation system. The waterwall tube arrangement provides maximum cooling of directional vanes, nozzles and other burner parts and reduces to a minimum the possibility of slag adhesion when coal is being burned. No burner refractories are required.

### Coal Burning

Two or three burner nozzles per burner are provided when coal or other solid fuels are to be burned. In this way the coal streams are more evenly distributed across the furnace to assure good mixing of fuel and air in the furnace.

### Oil Firing

A retractable type oil gun is inserted thru the center slot so as to provide complete mixing of the spray with the air stream. Oil can be burned with either steam or mechanical atomizing equipment.

### Gas Firing

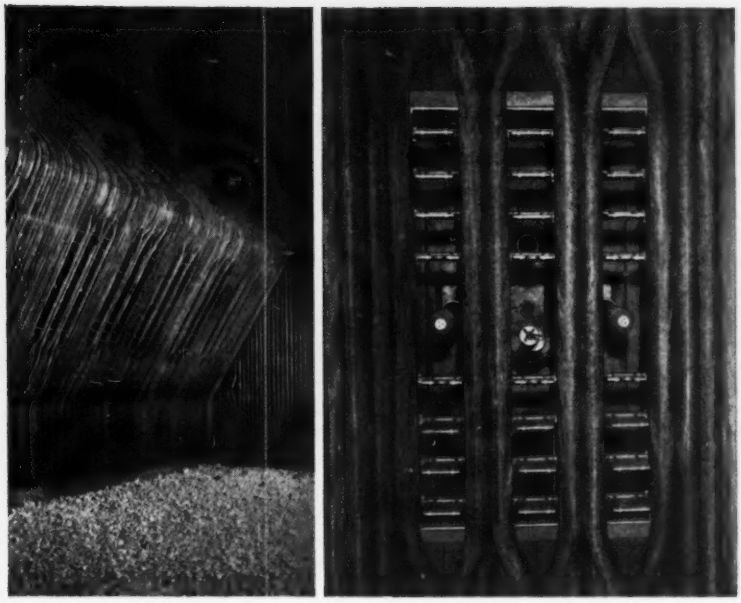
Gas is fired thru guns of high alloy stainless steel. High capacity burners have a gun in each side slot. Gas guns can be installed for mechanical retraction.

**A RILEY TURBO FURNACE GIVES YOU THESE MONEY-SAVING ADVANTAGES**

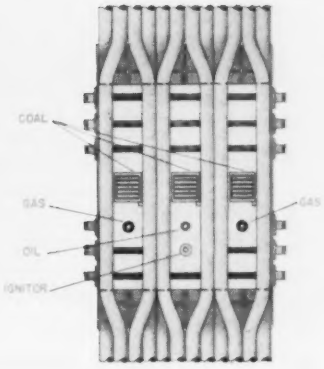
- **The ability to fire multiple fuels: gas, oil and a wide range of solid fuels**
- **A low cost and quick conversion to solid fuels with initial gas/oil firing**
- **Higher heat release with lower overall structure**
- **When firing coal**
  **low carbon loss**
  **clean furnace, no slagging**
  **elimination of flyash removal with reinjection**
- **One level burner operation**

**TWENTY THREE RILEY TURBO FURNACE UNITS HAVE BEEN SOLD SINCE ITS INTRODUCTION IN LATE 1954!**

# Directional Flame Burners in a RILEY TURBO FURNACE



gas guns, gas electric ignitor, observation port. Burner can easily be converted to oil and coal firing.




RILEY
DIRECTIONAL FLAME BURNER
Pulverized Coal, Oil and Gas

### Directional Vanes

Each slot is provided with directional vanes to project secondary air into the furnace so as to secure the desired placement of flame for most effective combustion. The vanes above the burner centerline and those below each have separate controls. Vanes are made of high heat resisting alloy.

### Burner Shut-Off

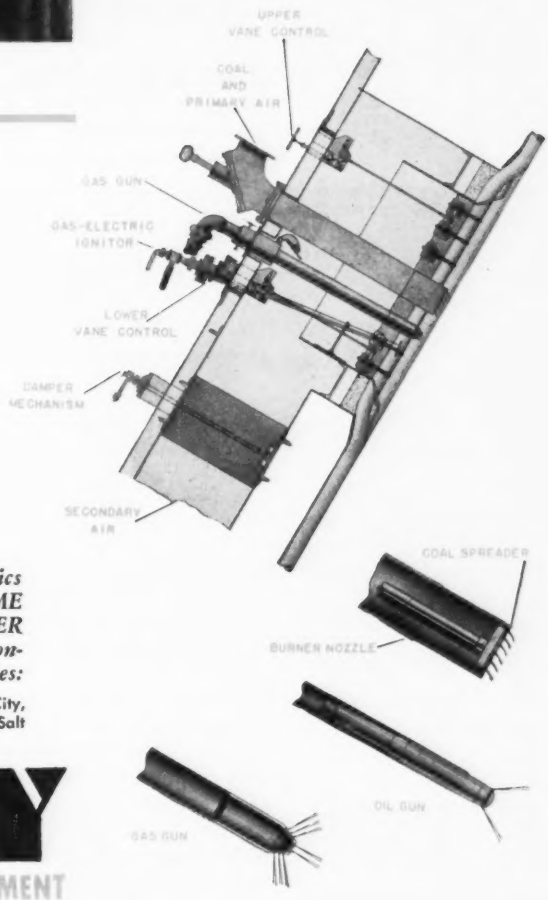
Each burner has a separate secondary air shut-off damper which can be locally or remotely controlled.

### Riley Gas-Electric Ignitors

Riley Gas-Electric Ignitors are available with Riley Directional Flame Burners.

### Pressurized and Non-Pressurized Operation

Riley Directional Flame Burners are designed so that they can be used either with pressurized or non-pressurized furnaces.



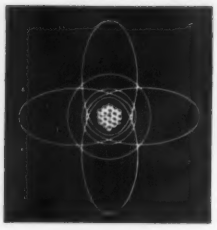

*The complete story about the unusual operating characteristics of the Riley TURBO FURNACE and DIRECTIONAL FLAME BURNERS can be obtained by writing RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS or contacting a Riley representative in any one of these cities:*

Chicago, Cincinnati, Cleveland, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, Seattle, St. Louis, St. Paul, Syracuse, Worcester.

RILEY
STEAM GENERATING & FUEL BURNING EQUIPMENT



For more facts circle 241 on Reader Service Card, p 117



# Nuclear notes

By B G A SKROTZKI, Associate Editor

**Advanced gas-cooled reactor plant** gets under way with signing of contract by AEC with East Central Nuclear Group, Inc and Florida West Coast Nuclear Group for research and development. Plant will be built in Florida West Coast area under the Power Demonstration Reactor Program. East Central will do research to develop a heavy-water-moderated gas-cooled pressure-tube reactor. Cost of $18 million will be shared about equally by East Central and AEC. AEC assistance is $13.2 million including waiving fuel and heavy-water use charges. The Florida Group will spend $26 million to build plant and about $1 million per year in excess operating cost for about 5 years. Plant will be 50 mwe, burn slightly enriched uranium.

**Reactor byproduct,** krypton-85, availability has been raised to 100,000 curies per year. Kr-85 can be used in place of radium and polonium for self luminous signs and cause less deterioration of the phosphor that glows. It also costs less. Kr-85 is widely used in thickness gages for paper, plastics, rubber and other material production. It has a half life of 10.27 years, decaying to rubidium-85 by emitting beta particles and gamma rays. AEC price for Kr-85 is $50 per curie for the first two and $15 for each additional curie.

**The Atomic Industry — 1958,** published by Atomic Industrial Forum, 3 East 54th Street, New York 22, N. Y. shows progress made during the year in all areas of reactors, uranium mills, radioisotope applications and governmental actions. The 12-p pamphlet costs $1.25, order from Forum directly.

**During 43-day run** the Sodium Reactor Experiment (SRE) in the Santa Susana Mountains of California has produced 3933 mwhre. Since starting in July 1957 the SRE has produced 10,923 mwhre. The output goes to Southern California Edison's system. The 20.2-mwt reactor drives a 5.8-mwe turbine-generator. Sodium enters the reactor at 536 F, leaves at 900 F to generate steam at 600 psi and 770 F. Reactor can change from full to half power in 2½ min without varying temperature.

**Nuclear Liability Insurance and Indemnity,** a committee monograph published by the Atomic Industrial Forum, see above, reviews the current proposals for private insurance and government indemnity. The report suggests methods of closing gaps in coverage left by the proposed policies; 28-p pamphlet costs $1; order from Forum.

**Significant opinions** from talk by W K Davis, vice-president, Bechtel Corp before Symposium on Nuclear Fuel Elements in New York City, Jan 28, 1959: "The development of design procedures for reactor cores has led to a firmly established ritual of 'hot channel factors' and peak-to-average ratios. These have proven to be useful design tools in an exceedingly complex technical problem. However, while these procedures have been helpful I believe that they are now often misused and misunderstood and that their use now often leads to excessively conservative core designs. . . . Unfortunately, with a few exceptions, reactor cores are not being furnished with sufficient instrumentation or the proper type to determine what the capabilities of a core are or to provide adequate data to permit a verification or analysis of the original design. Even those reactors that have operated with highly instrumented cores do not seem to have been subjected to critical analysis in terms of the design procedures originally used."

# You get these benefits when you install YARWAY GUN-PAKT EXPANSION JOINTS

Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

Because with Yarway you get:

- **CONTINUOUS SERVICE**
  Costly shutdowns are eliminated. Packing is seldom necessary but may be added *under full line pressure.* No vents are necessary. Never needs repacking.
- **RUGGED DEPENDABILITY ALL STEEL CONSTRUCTION**
  Durable chromium plated seamless steel sleeves. No chance *of metal fatigue.* Wrought steel bases provide rugged, positive anchorage.
- **INTERNAL AND EXTERNAL GUIDES**
  Positive alignment of sleeve in stuffing box *—where it counts!*
- **LIGHT WEIGHT, STREAMLINED DESIGN**
  Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

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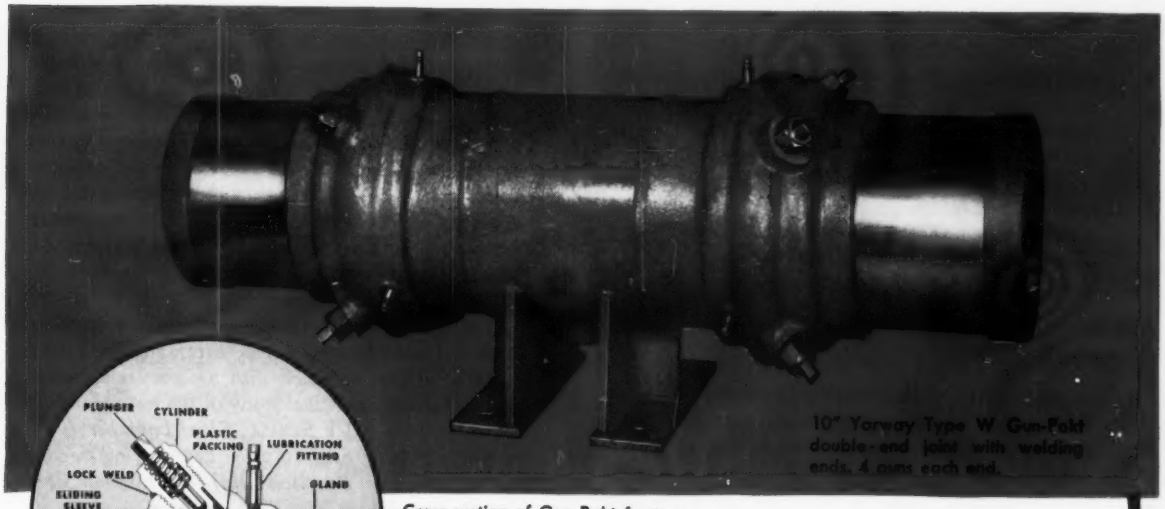
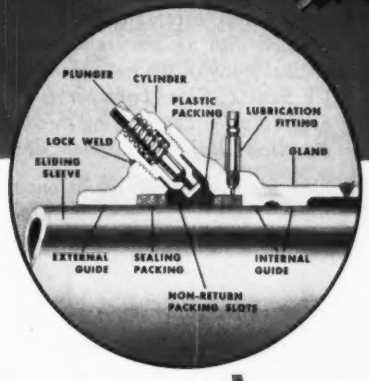


10" Yarway Type W Gun-Pakt double-end joint with welding ends. 4 guns each end.




Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

**YARWAY GUN-PAKT**



For more facts circle 243 on Reader Service Card, p 117

# Reserved for your comment

BOB BELLAS, Associate Editor

## As you like it

POWER's new "structure" is strictly to my liking and, since you want reader reaction ("You asked for it," January, p 51), here's mine:

It's a considerable improvement over the old system which slowed my reading and made it tougher to clip and save articles for reference. Having to turn to back pages, then more back pages, to follow an article to its conclusion has always been one of my pet peeves. A vote of thanks for the change.

H J STRUCK, *Milwaukee, Wis.*

. . . With reading hours at a minimum for most of us in the engineering profession, it was indeed a pleasure to pick up your January issue. It is certainly a great timesaver and a change which we feel sure will merit the commendation of the majority of your readers. CONGRATULATIONS.

ERIC H SMITH, *Chief Engineer*
*Riley Stoker Corporation*

. . . At last—a "no-skip reading" magazine. It's tops. POWER has always been my first choice for the latest and best data, particularly on electrical apparatus. Hats off to you for making technical magazine reading easier by giving us these "packaged" articles.

A C ROE, *St. Louis, Mo.*

EDITOR'S NOTE: *Hats off, too, to Reader Roe. Recently retired as a Westinghouse consulting and design engineer after 46 years with the company, he has been appointed a staff engineer by the National Industrial Service Association. Prominent electrical engineer and author (six books on ac and dc motor repair and some 500 technical articles), Mr Roe will play an important part in NISA's constantly expanding activities both in this country and abroad.*

## Time will tell

In your article ("High heat transfer for stainless," February, p 75) the alleged close approach of the "U" values of the stainless steel to that of the admiralty is amazing. This may be partly accounted for by the large percentage of 20-gage stainless tubes used. However, it is admitted that this valus is small, since it only accounts for about 4% change in the "U" for stainless. There is a possibility that stainless steel promotes drop-wise condensation to a greater degree than arsenical-admiralty, which would normally improve the former's heat transfer properties over those of the latter.

A performance-characteristics study of the two kinds of tubes reveals that for a circulating water velocity of 7 fps, the absolute pressure for the stainless side of the condenser is 0.03 to 0.07 in. Hg worse than that for the arsenical-admiralty side for circulating-water inlet temperatures of 66 to 80 F respectively. Although the differences appear to be small, resultant added fuel cost to generate power in our system, by a unit of equivalent size equipped with stainless condenser tubes, would be about $3000 per year. This added cost plus the higher cost of stainless tubes (about twice that of arsenical admiralty) would prohibit its use in our condensers. It would be interesting to learn how the life of the stainless tubes will compare with that of the arsenical admiralty. The guess here is that life of stainless tubes will be at least twice that of the latter. I hope POWER will keep us posted.

J STEPHEN UNGAR
*Consolidated Edison Co of N. Y., Inc*

. . . Steam condenser users as well as the condenser industry are indebted to the Delaware Power & Light Co for publishing the test results obtained from this unusual installation. For the first time in the history of steam condenser development direct comparison of the heat-transfer characteristics of stainless steel with those of admiralty metal in a single unit has been made possible.

Stainless-steel use for the complete heat-transfer surface of a steam condenser is seldom justifiable because of its cost and its relatively low thermal conductivity when compared with the more common copper-base alloys. It is assumed, in this case, that the choice of stainless steel as a satisfactory replacement material was based on: (1) an anticipated increase of service life of stainless and (2) compensating for a significant portion of expected heat-transfer loss by using a thinner tubewall than is normally used with admiralty metal.

The excellent heat-transfer performance obtained with the stainless-steel tubes, averaging from 91.6 to 96% of that obtained with the admiralty metal, merits further analytical study of the test results.

J F SEBALD, *Chief Engineer*
*Steam Power Engineering Section*
*Harrison Div, Worthington Corp*

EDITOR'S NOTE: *Steve Elonka wants to point out to "Operators' Notebook" readers that two important commas were omitted on p 120 of Dec 1958 issue.*

*Referring to the A W Chesterton Co's new magnetic seal, the sentence "Seal has been used to 5000 psi at 550 F and at shaft speeds of 20,000 fpm" should have had commas setting off the "at 550 F" because it's impossible for any mechanical seal to operate under these conditions simultaneously.*

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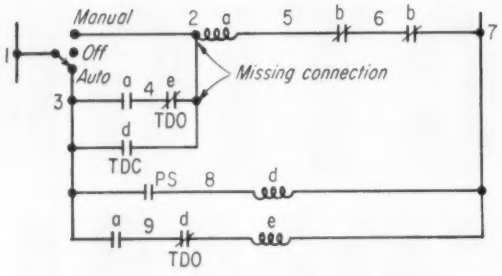
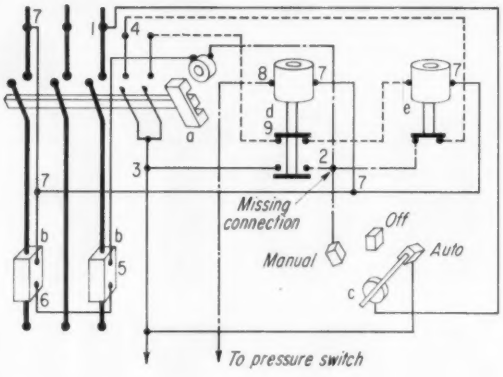
# More **comment**




## Don't forget to eye your dots

I almost went into orbit while trying to trace out your first pump control diagram. (*Plant Electrical Fact File*, Jan 1959, p 172). Finally came the dawn as I made up an elementary diagram, left, above, from your written explanation. Your draftsman left out *one* important connection dot. Right?

I enjoy your *Fact File* and suggest it would add interest if you'd deliberately make such errors. They'd be dandy for use in teaching trouble-shooting from diagrams. Another suggestion: How about making your regular diagrams easier to follow by including "elementary" companion diagrams? Too, it would be helpful if you would assign numbers to identify each connection.

A G KERVINK, *Buffalo, N. Y.*

EDITOR'S NOTE: *Reader Kervink surmised correctly that the important connection dot was left out by the draftsman. Truth of the matter is that we just weren't on our toes when the drawing came up for editorial check.*

*Says Associate Editor Norm Peach, "If we should deliberately make an incorrect connection as an aid in teaching trouble-shooting, we'd have to let the reader know something was wrong, though we wouldn't tell him what it was." Norm adds, "Here's a sketch, above, right, showing corrected circuit, with connections numbered according to the schematic diagram supplied by Mr Kervink. A pair of diagrams such as this goes a long way in showing how a circuit gets a particular job done.*

## New deal

In the last paragraph of Mr Beardmore's article, ("Torque-speed is your motor guide for boiler-feed pumps," Jan 1959, p 64) the critical words are "high starting current." These say that GE motors have high starting currents.

But this isn't the case. The article was intended to show that the increase in starting current was small and incurred only under extreme conditions. Mr Beardmore would prefer to have this thought expressed as follows:

"Increasing motor resistance, which slightly reduces full load speed, will provide ample additional torque for accelerating to full speed. Only when voltage is very low or where check valves open at unusually low speed will it be necessary to make a small increase, perhaps 5%, in starting current."

R J WYLLIE
*Medium AC Motor & Generator Dept*
*General Electric Co, Schenectady, N. Y.*

## That's what makes horse races

I was quite interested in what W C Burns had to say about aluminum for demineralized-water storage. (*Plant problems*, Jan 1959, p 176.)

But apparently others disagree with his opinion. Several major utilities have standardized on aluminum condensate storage tanks. And it's commonplace in atomic energy laboratories, pharmaceutical and chemical plants, industrial and academic laboratories to store and handle their high purity water in aluminum tanks and piping. Television tube manufacturers also use aluminum tanks and pipe for this service to avoid introduction of harmful heavy metal ions. Actual quoted price of aluminum tanks will vary with size, fabricator's experience and how hungry fabricators are for business. *SMJ* should contact his nearest Alcoa office for names of experienced fabricators.

E D VERINK JR, *Manager, Chemical Section*
*Sales Development Div, Aluminum Co of America*

# Why a Steam Trap Has to Handle "Air"

## Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

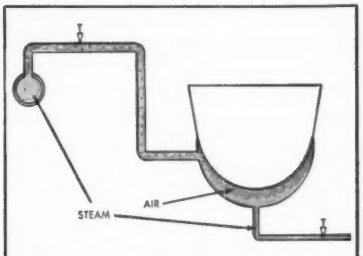



Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

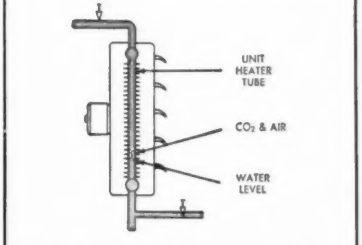



Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both,* at steam temperature, *as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. $CO_2$ gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. $O_2$ aggravates the situation. See Figure 2.

**TABLE A—How air reduces steam temperature.**

| Gauge Pressure | Temp. of Steam with No Air Present | Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume) | |
|---|---|---|---|
| | | 10% | 30% |
| 10.3 | 240.1 | 234.3 | 220.9 |
| 25.3 | 267.3 | 261.0 | 246.4 |
| 50.3 | 298.0 | 291.0 | 275.1 |
| 75.3 | 320.3 | 312.9 | 295.9 |
| 100.3 | 338.1 | 330.3 | 312.4 |

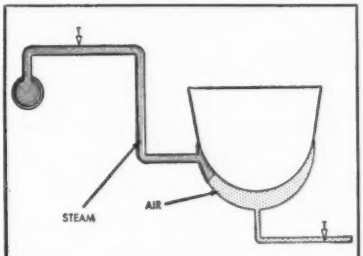



Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

### Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

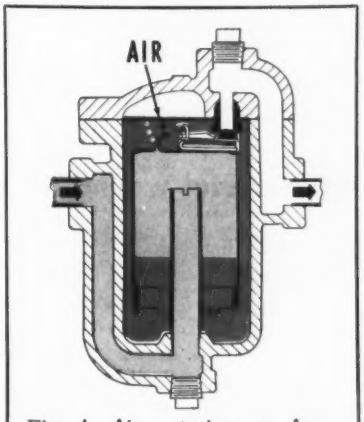
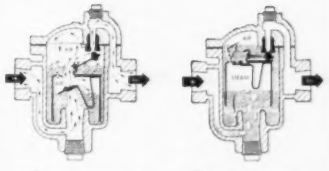



Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



*Thermostatic vent open.* *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

### Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8127 Maple Street, Three Rivers, Michigan.

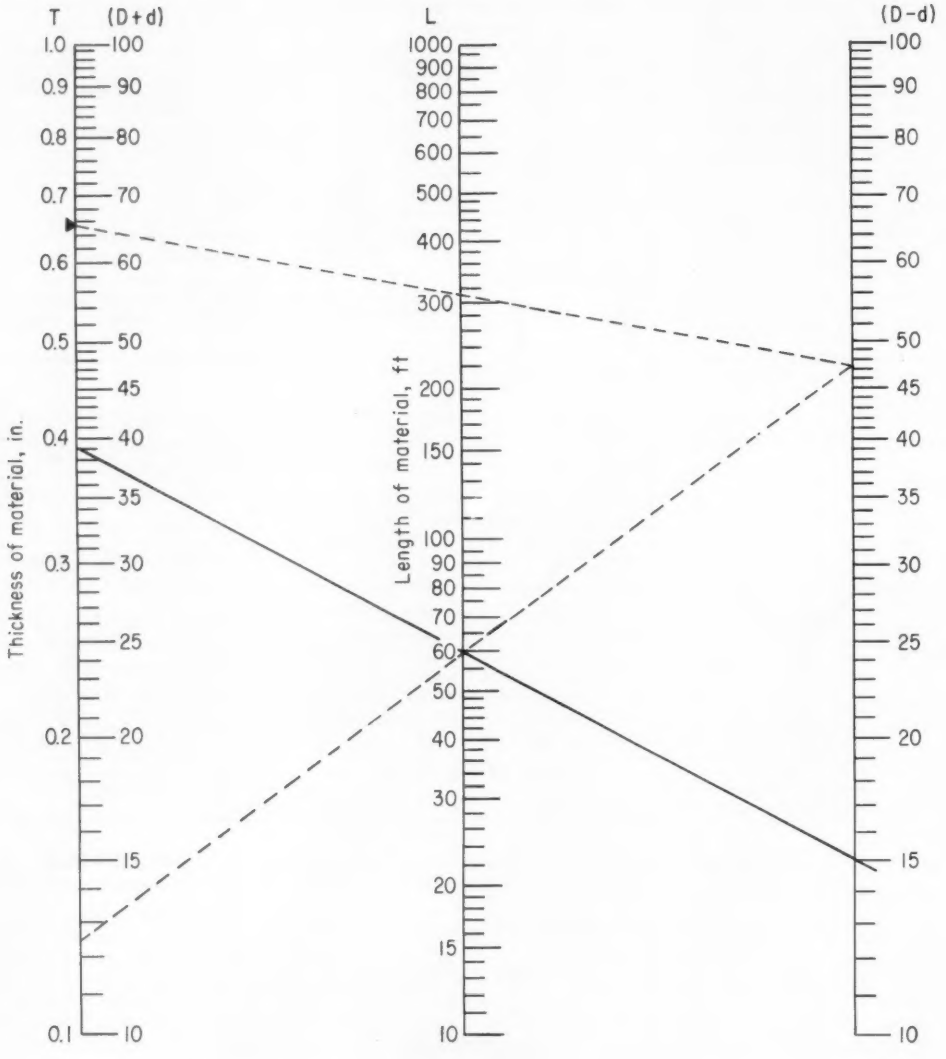
**ARMSTRONG STEAM TRAPS**



For more facts circle 245 on Reader Service Card, p 117

# Power's data sheet

No. 320




## Length of material wound on a spool

Here's a quick way to estimate the length of belting, wire, rope or cable wound on a spool. This nomogram is based on the formula:

$$L = \frac{0.0655\ (D + d)\ (D - d)}{T}$$

where $D$ is outer diameter of material wound on spool, in.; $d$ is diameter of spool, in.; $T$ is thickness of material, in.; $L$ is length of material, ft.

*Example:* Find length of rope wound on a spool with a diameter of 12 in. Overall diameter of the spool and material is 27 in. The diameter of the rope is 0.125 in.

Add $D + d = 39$ in., and spot on the left-hand scale. Subtract $D - d = 15$ in., and spot on the right-hand scale. Connect with straight edge and locate intersection on the center scale. Next spot 0.125-in. thickness on left-hand scale and connect with intersection on center scale to find second intersection on right-hand scale. Connect this intersection with 65.5 on $D + d$ scale and read the answer on the center scale, 307 ft.

—S Salva, *Jackson, Mich.*

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This dollar-saving **Solid Wedge Gate** shows it pays to

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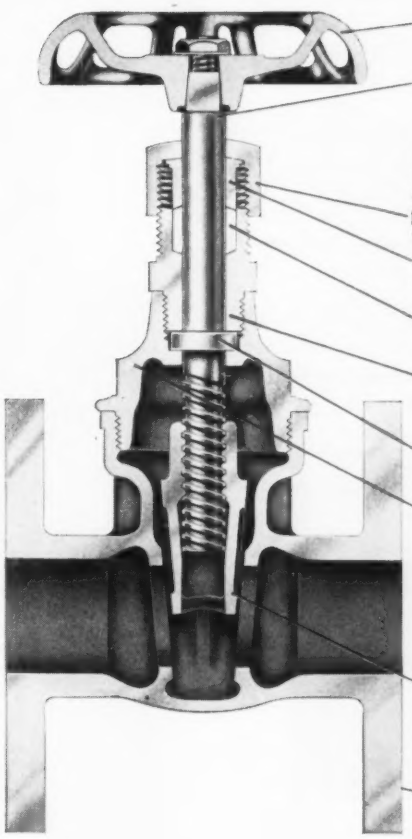
BECAUSE Jenkins puts an extra-measure of quality in this Fig. 1300 Solid Wedge, Inside Screw Gate Valve you will find it satisfies the needs of many services for which a more costly type often would be used. Look at the many superiorities in design and construction shown here. You'll conclude that it's hard to beat Jenkins at making valves, no matter what the material.

But no picture can show the quality of the castings . . . the precision machining . . . the rigid inspection and testing that have gone into this valve. All of these are as important as design and metal alloys in assuring long, dependable, economical valve service. And, all of them are up to the peak standards for which Jenkins has been known for almost a century.

SEND FOR NEW CATALOG of Jenkins Stainless Steel Valves, in patterns and alloys that satisfy the requirements of practically all corrosive services. These Jenkins Valves meet valve industry specifications and the high standards established by leading users of stainless steel valves.



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**PACKING NUT** is strong and deep for full thread engagement.

**PACKING GLAND** is a self-centering design to afford tightness without excessive friction on spindle.

**PACKING** — A Teflon ring in a large capacity box requires less frequent replacement.

**PACKING BOX NIPPLE** assumes thrust when closing valve. It is extra heavy, with hex flats larger than diameter of bonnet face to prevent leakage.

**SPINDLE COLLAR**, integral with spindle, is large and wide to resist thrust and shearing strains.

**BONNET** is a rugged unit, with accurately machined threads to assure tight joints with the body and packing box nipple. Top of wedge and corresponding face inside of bonnet are machined to insure perfect spindle alignment and backseating for repacking valve under pressure.

**SOLID WEDGE** is tapered equally on both faces. Lugs on sides of wedge engage guide ribs in body to reduce drag and minimize chatter.

**BODY** has best combination of wall thickness and shell design to withstand pipeline stresses. An integral seat minimizes corrosive attacks.

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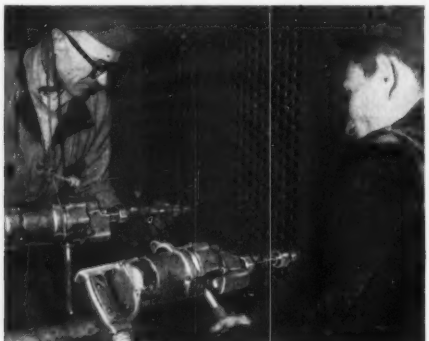

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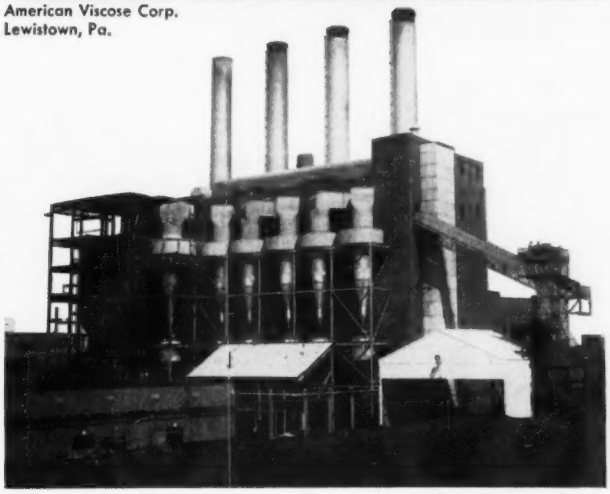

American Viscose Corp., Front Royal, Va.

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# Now's the time to prevent freezing of heater coils... with Production Planned steam trapping

*By John W. Ritter, Test Engineer, SARCO Company, Inc.*

Freezing of heating coils usually takes place when outside air temperature is slightly below the freezing point, and it is most common in coils that have the steam supply controlled by a temperature regulator which keeps the outlet air temperature constant. Freezing can occur only when the coil becomes water-logged, and in this case the steam trap is often blamed for the trouble.

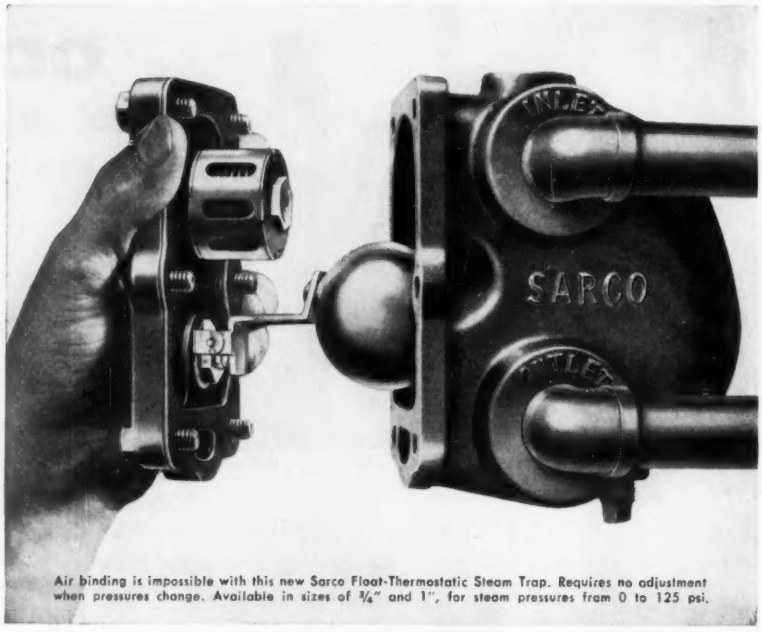
The discharge capacity of any steam trap depends upon the difference in pressure between the trap inlet and its outlet. If there is no pressure difference, the trap cannot remove condensate; and if inlet pressure is lower than outlet pressure, condensate will be held back in the coil.

There are three ways to avoid this difficulty. First, a pressure controlled bypass can be arranged around the temperature control valve to prevent heater pressure from falling below a preset minimum. This plan would make the temperature controller ineffective over part of the range of outside air temperature.

A better solution is to install the steam trap well below the unit, and thus provide a hydraulic leg to enable the trap to discharge even with a vacuum in the steam space. An ample sized vacuum breaker should be installed at the top of the steam inlet of the heater.

To compute the hydraulic head needed, use a figure of 3′ per 1 psi pressure differential. For example, if the trap has the required capacity at 1 psi differential, the minimum head will be 3′.

Thirdly, on new construction, the preheater can be divided into two sections. The first should be capable of raising the air to at least 32° under minimum outside air conditions. The second section should raise the air from 32° to the final temperature. Full steam is supplied to the first coil at all times, while the second is controlled to maintain the final temperature needed. The first coil will not freeze because of the maintained pressure, nor will the second, because minimum air temperature is always above 32°.

Air binding is impossible with this new Sarco Float-Thermostatic Steam Trap. Requires no adjustment when pressures change. Available in sizes of ¾" and 1", for steam pressures from 0 to 125 psi.

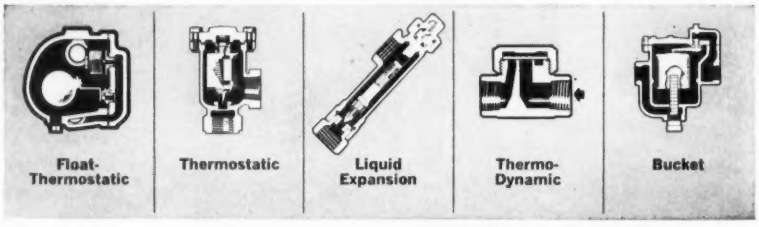
## A SARCO F-T Steam Trap will drain condensate completely

Count on the Sarco Float-Thermostatic Steam Trap to discharge condensate practically at steam temperature, continuously and without shock. Sarco F-T's do not cause pressure fluctuation while discharging.

For *production planned* trapping of heating coils, with accurate temperature control, use the new Sarco Steam Trap Type F-T.

Write for Technical Bulletin T502 on prevention of freezing in heater coils. You'll also receive a bulletin on Sarco F-T Steam Traps.

Remember that Sarco can give you *impartial* advice on steam trapping because only Sarco makes all 5 types. 5968-B

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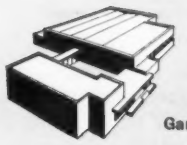

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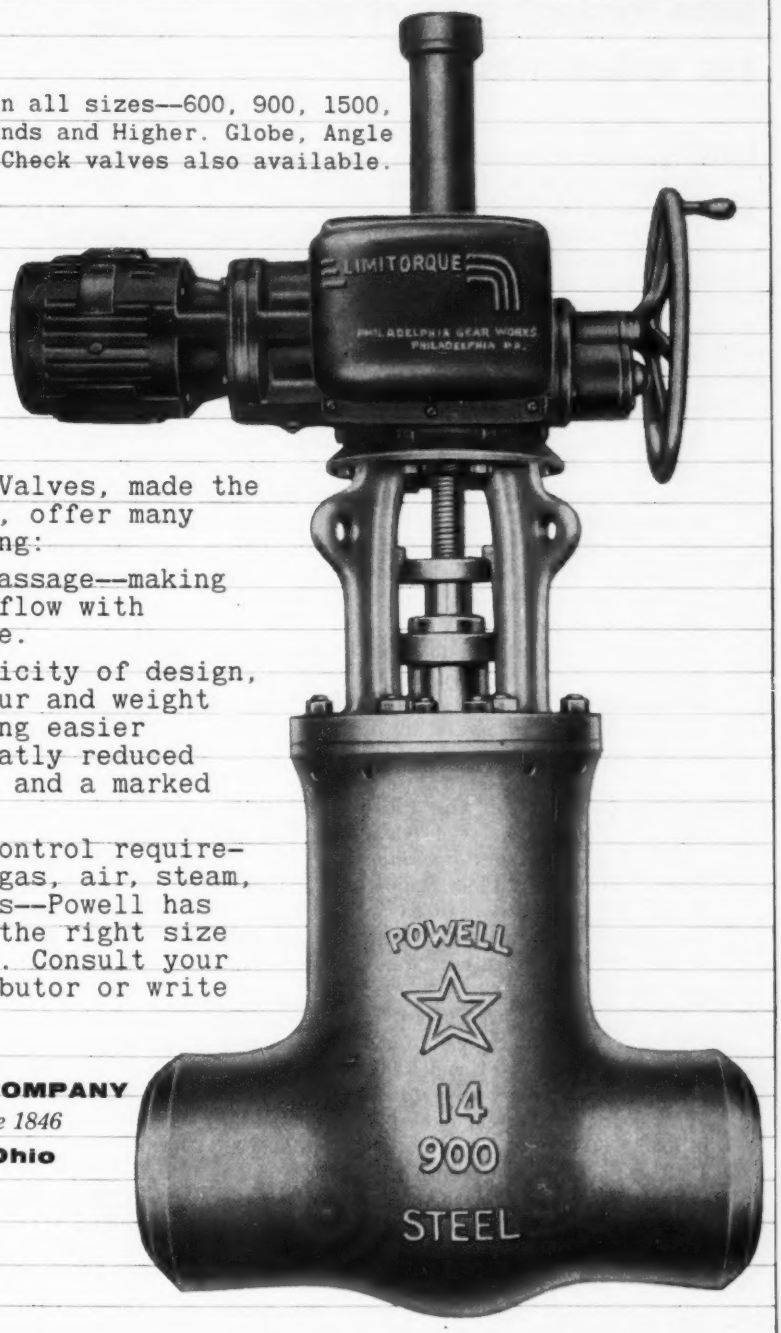


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# Technical briefs . . . Latest engineering

## Subcritical, supercritical once-through boilers pass test milestones

**Initial operating experience with monotube once-through boiler at subcritical pressure,** *J D Williamson, The Dayton Power and Light Company*
The first subcritical once-through boiler in the U.S. has been operating at the F M Tait Station of The Dayton Power and Light Co since June 12, 1958. Designated Unit No. 4, the boiler-turbine is 130-mw capacity at 2400 psig, 1050/1000 F, and designed to burn low-grade strip coal.

Two other firsts go along with this unit: (1) First use of fire-resistant hydraulic fluid in Sulzer control system (2) first welded condenser tubes.

Main problems to date have been air entrainment in control fluid, distorting of stainless-steel sheets in deaerator, bulging and cracked generator tubes. In each case the difficulty has been corrected or will be at the next scheduled outage. Other troubles fell under those normal to the first operating period of a new unit.

Operation of unit and the way it differs from standard boilers are discussed in detail. Author points out that favorable features of unit so far give promise of a successful operating future. *ASME paper 58-A-286*

**Thermal performance of the Philo supercritical unit,** *A S Grimes and J A Tillinghast, American Electric Power Service Corporation*
When Unit No. 6 at Philo Station went on line in March 1957, plans were already in the hopper to run extensive heat rate tests. These tests took place in July 1957. Further tests were run during the first part of 1958.

The July tests showed a heat rate of 8824 Btu per hr at 1½-in. backpressure and steam at 4500 psi, 1150 F with 1050 F and 1000 F reheats. Heat rate includes auxiliary power of 12,900 kw. Tests in 1958 disclosed a heat rate of 8886 Btu per hr, including 11 startups from Nov 1, 1957 to May 31, 1958, and hot restart tests in Jan 1958.

Major problem during this period was operation of high-pressure feedwater pumps. Original seals bound and were replaced by conventional sleeve type bushings requiring large amounts of cool condensate to prevent flashing. Tests showed pumps used 1000 kw more than first estimates. A second problem involves copper deposits on turbine blading.

Directions for ordering these papers on page 110

More than a year's operation indicates special precaution must be taken in the areas of water chemistry and mechanical design so benefits from supercritical conditions are not tempered by additional cycle losses. *ASME paper 58-A-297*

### Heat balance

**Power heat balance considerations in design and operation of industrial plants,** *J I Hudson, E I du Pont de Nemours and Co, Inc*
Relation between design of process equipment and power-service facilities is one of the keys to an economical plant. "Power services" refers to electricity, steam, refrigeration, compressed air, water of different qualities and other utilities supplied by industrial power plants. Author uses typical examples to illustrate the influence of different factors affecting services selected.

Once equipment is installed and operating, use of a performance rating supplies a measuring stick for judging relative plant operation. A triple-objective system used by du Pont is discussed, including what factors are and are not used to measure, how these factors are weighed and how they are put to use. *ASME paper 58-A-166*

**The utilization of waste heat,** *J H Potter, Stevens Institute of Technology*
Sound waste-heat projects are generally built around continuous rather than batch operation processes. Justification for waste-heat recovery depends on: (a) improving the process (b) contributing to the improvement of a larger system of which the process is a part (c) providing external services (d) combinations of these three factors.

Discussion of various apparatus used in waste-heat cycles points out different possibilities and cycles. Present trend in use of waste heat indicates fewer cycles will be used for power generation. Also, greater heat-recovery effort will be made where energy can be returned to the process. Simpler apparatus and equipment that can best use higher temperatures will be sought. *ASME paper 58-A-167*

### Circuit breakers

**The *X/R* method of applying power circuit breakers,** *J E Skuderna, U.S. Bureau of Reclamation*
In 1954 an AIEE Working Group proposed a new basis for rating power circuit breakers. Later another Working Group recommended using multiplying factors for calculating fault currents so the characteristics of the Rated Short Circuit Current (a combined rating of making, latching and interrupting current ratings) could be compared

with the decrement rates for symmetrical and asymmetrical fault currents on high-voltage systems. Finally, a third AIEE group was formed to consider a simplified method for making these comparisons. This new method is called the $X/R$ method and was proposed by the author.

Paper gives the basis of the $X/R$ method, shows how to calculate 3-phase and line-to-ground faults and how to apply circuit breakers. Comparison is made between this and the multiplying factor method with advantages and disadvantages of both explained. *AIEE paper 59-41*

**Some improvements in high-speed circuit breakers,** *C I Clausing, I-T-E Circuit Breaker Co and D I Bohn*

Design factors of first importance governing design of a circuit breaker (high speed, current-limiting anode type breakers for protecting mercury arc rectifiers) are minimum contact parting time, minimum arcing time and most desirable closing means. Using this list as a starting point, the authors describe the steps leading to development of a new breaker.

The armature is made of three segments placed side by side. They achieve the same result as a long slender armature in an air gap between two magnetic poles, namely, combining minimum armature mass and a large holding force. A special blowout coil added to the arc chute has no external iron circuit, arc transfer or secondary blowout coils, but blowout flux is present whenever current is flowing.

A motor, driving through a gear train and slip clutch, operates an overcenter toggle for closing the breaker. A control relay starts the motor which then drives the toggle against a stop after which the motor coasts to a stop with the clutch slipping. *AIEE paper CP-59-254*

**Motor starting lamp flicker on open-delta transformer banks,** *J C Neupauer, Westinghouse Electric Corporation and C L Smith Jr, Light, Water and Sewerage Dept of City of Griffin, Griffin, Ga.*

Open-delta transformer banks fit well in installations serving large single-phase loads and small 3-phase loads from the same bank. Also, they provide the most economical arrangement for this service. A drawback, however, is that there is little information indicating the expected voltage fluctuation when motors are started from these open-delta transformer banks. Purpose of this paper is to provide such data.

Studies so far show leading connections produce less lamp flicker than lagging connections when motors are started. Also, you can control the amount of flicker by increasing transformer sizes, conductor sizes or by applying reduced voltage starters. Finally, the kva ratings of helper transformers has little effect on flicker voltage.

Equivalent circuits were worked out (and included in the paper) to ease the job of analytical studies. *AIEE paper 58-1172*

## Motor protection

**Squirrel-cage motor characteristics useful in setting protective devices,** *F R Karr, Westinghouse Electric Corporation*

Starting or acceleration period, stalled or locked rotor and running overload are three operating conditions which can damage a squirrel-cage motor. If the accelerating time exceeds 135% of the recommended locked-rotor time the application should be reviewed. A method is given for calculating accelerating time using speed-torque curves and a relatively simple formula.

For applications approaching locked-rotor conditions—long accelerating periods of high inertia loads—the application engineer should get together with the motor designers to make sure the motor applied is properly protected. Paper discusses locked-rotor time and running overload from a protection viewpoint along with accelerating time.

Several examples are spelled out in the appendix for calculating acceleration time and effect of overload on insulation. These can be used as a guide to indicate possible trouble spots in motor applications. *AIEE paper 59-13*

**Factors influencing starting duty of large induction motors,** *V J Picozzi, General Electric Co*

Since control engineers are usually familiar with the full-load characteristics of induction motors, emphasis is on starting conditions.

Under stalled conditions a large induction motor is generally limited by the maximum safe rotor temperature rather than the maximum safe stator temperature. Safe stall time depends on the motor design; for large induction motors it varies from 4 sec for 4000 hp to 20 sec for 250 hp. For a given connected $WK^2$ and no load torque, rotor heating is independent of accelerating time; load torque increases rotor heating during acceleration, as does reduced voltage acceleration. Another danger of reduced voltage acceleration is the possibility of the motor sticking at some speed below maximum torque, resulting in cracked bars and end rings, loosened rotor core, melted rotors—all from overheating.

A NEMA table (included in the paper) defines safe load $WK^2$ for given horsepowers and speeds and equals a basis of good application. Departures from this are special designs and application of wound-rotor motors should be considered. *AIEE paper 59-38*

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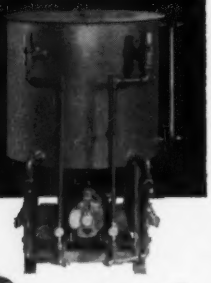

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## Technical briefs

Begins on page 102

### Reserve load

**Determination of reserve and interconnection requirements,** *H D Limmer, Public Service Electric and Gas Company*

The probability of loss of load is a measure of the reliability of a system. A medium-sized digital computer can be programmed to calculate conveniently the effects of machine sizes, machine-outage rates, load-forecast accuracy, scheduled maintenance and the load-duration curve.

The author believes the following conclusions to be generally correct: (1) In the range of generally accepted reasonable values of probability of load loss, the latter decreases very rapidly with small increases in interconnection capacity. (2) The assumptions concerning the forecast accuracy are the most influential in determining the probability of loss of load, given a fixed number of interconnections and amount of reserve capacity. (3) The use of excessively large generators causes an appreciable increase in the interconnection capacity requirements, or in the system generating-reserve requirements. (4) Minor changes in generator outage rate have little effect on the probability of loss of load. (5) For typical systems studied to date, a combined generation and interconnection reserve of 22 to 26% is required if three-year-forecasting errors up to ± 10% are taken to be possible. Reserves of 30 to 35% are needed if forecasting errors up to ± 19% are considered possible. *AIEE paper 58-139*

**Determination of reserve generating capability,** *H Halperin and H A Adler, Commonwealth Edison Company*

Reserve generating capability studies of the type described in this paper have been used for two main purposes: (1) to furnish management with evaluations of reserves corresponding to varying degrees of reliability for use in determining required additions to generating capacity (2) to provide a basis for comparison of alternative plans for

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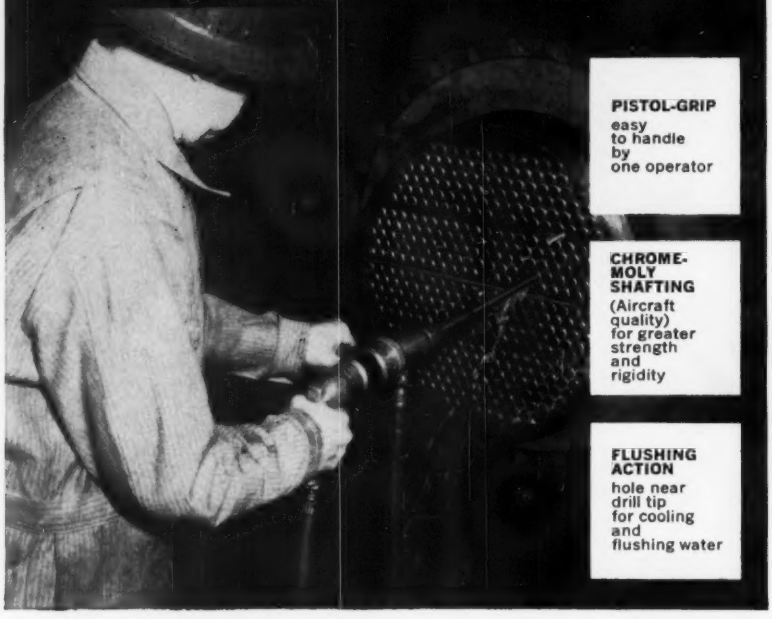
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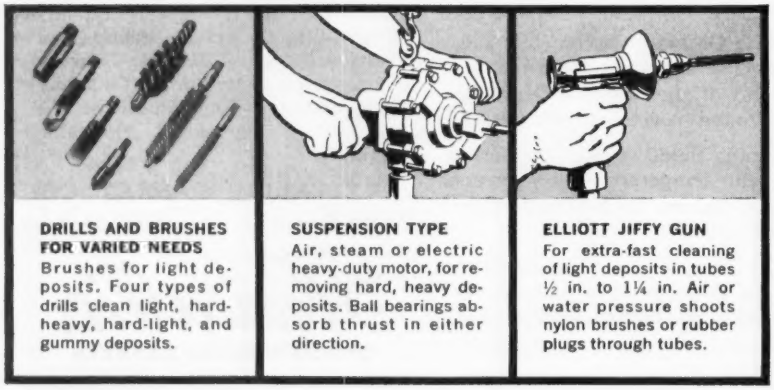

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## Technical briefs

Begins on page 102

system development, such as the effect of varying the size of units upon required reserve or the value of power supply over interconnections in place of increasing the owned generating capacity.

This basic approach has been developed to make reserve studies for the conditions and requirements of a large system:

(1) Determine by probability methods the expected frequency and duration of forced outages of generating capacity. (2) Schedule overhauling according to the "constant risk" principle. (3) Evaluate the required reserve capacity on the basis of estimated 12 monthly peak loads in a given year instead of the yearly maximum demand only. (4) Determine a monthly peaking factor to take into account the effect of variations in daily (weekday) peak loads within each month on the required reserve.

(5) Evaluate help during emergencies from power supplied by other utilities, from emergency loading of generating-station equipment, and from dropping interruptible loads. (6) Establish criteria of reliability on the basis of frequency of emergencies that system must be able to meet without voltage reduction or loss of load. (7) Make no specific allowance for possible deviations from forecast loads, with the understanding that calculated reserves are minimum recommended values. They may be increased by management, if desired on the basis of an overall evaluation. *AIEE paper 58-126*

## Fuels

**Induced air flows in fuel sprays,** *H Binark, Technical University of Istanbul and W E Ranz, University of Minnesota*

Air is an important component of a spray, particularly a fuel spray. Various rate processes in sprays are associated with and dependent on turbulent, convective, and diffusive transfer of heat, mass, and momentum between spray droplets and ambient gas. Since the exact nature of the dynamic conditions in the spray zone

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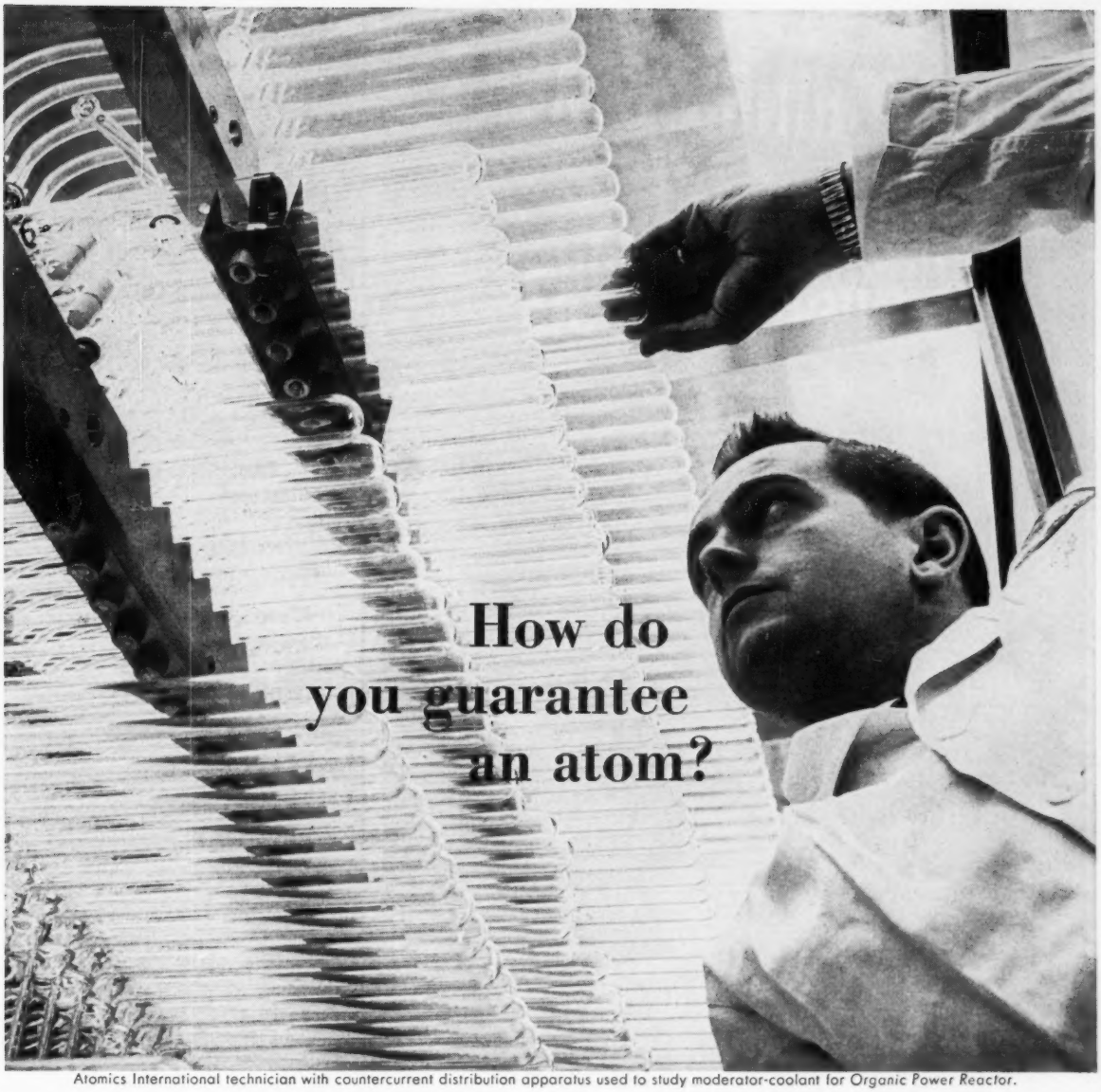


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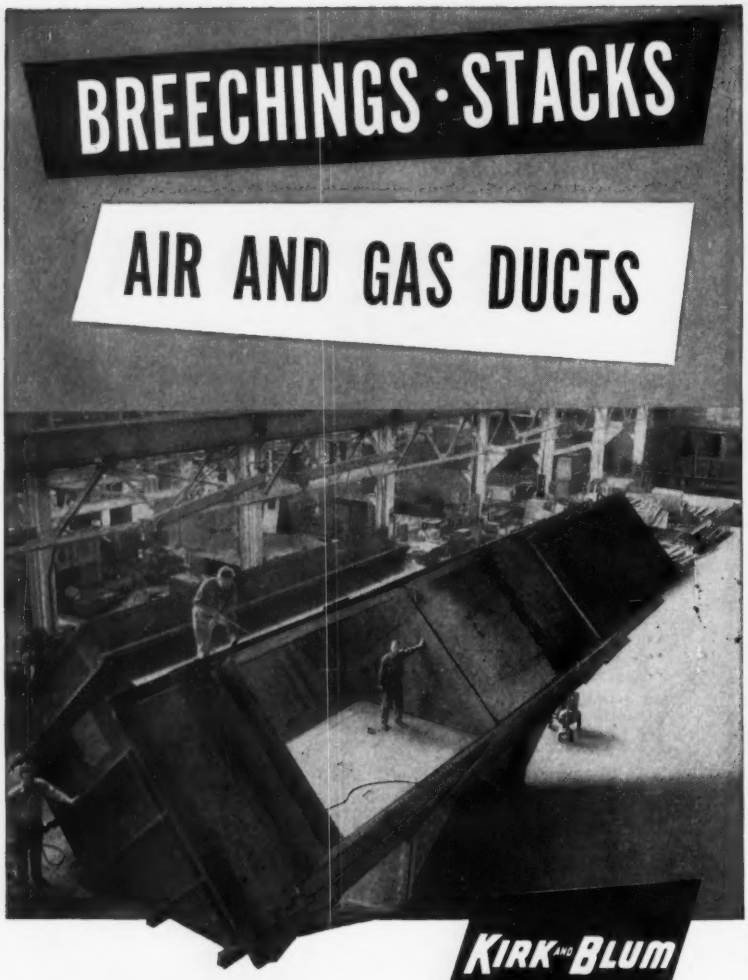


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## Technical briefs

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that control transfer rates has not been studied extensively, a series of experiments was run to demonstrate qualitative and quantitative aspects of induced air flow in and near the penetration zones of hollow- and solid-cone sprays.

Effect of liquid-supply pressure, spray-cone angle and nozzle size and a comparison between water and fuel-oil sprays is discussed, along with air flows in both hollow-cone and solid-cone sprays. *ASME paper 58-A-284*

**The effect of fuel types and admission method upon combustion efficiency,** *H N McManus Jr, Cornell University, W E Ibele and T E Murphy, University of Minnesota*
Little information of a basic or applied nature has appeared about use of the fuel vaporizer in aircraft gas turbines. Therefore a burner yielding maximum flexibility of air-admission patterns was constructed and operated with gaseous, spray and vaporized fuels. An atomizing fuel nozzle and a vaporizing tube were used in the burner.

Effect of combustion-chamber length for the three different fuel admissions upon combustion efficiency was studied under idential combustor geometry and similar air-flow patterns. Also, the effects of fuel-air ratio and full-section velocity and fuel volatility were examined.

Vaporizing-tube burner proved superior to the spray nozzle in combustion efficiency. However vaporizing tube performance fell off with decreased fuel volatility while spray nozzle was unchanged and even improved when used with kerosene. Test procedure and other results are given in detail. *ASME paper 58-A-128*

## Miscellaneous

**Operation experience with command-type load-frequency control equipment,** *W D Wilder, Niagara Mohawk Power Corp*
Load-frequency control equipment installed at Niagara Mohawk adjusts the output of two steam-generating stations to meet load swings within the Western Div and to maintain the

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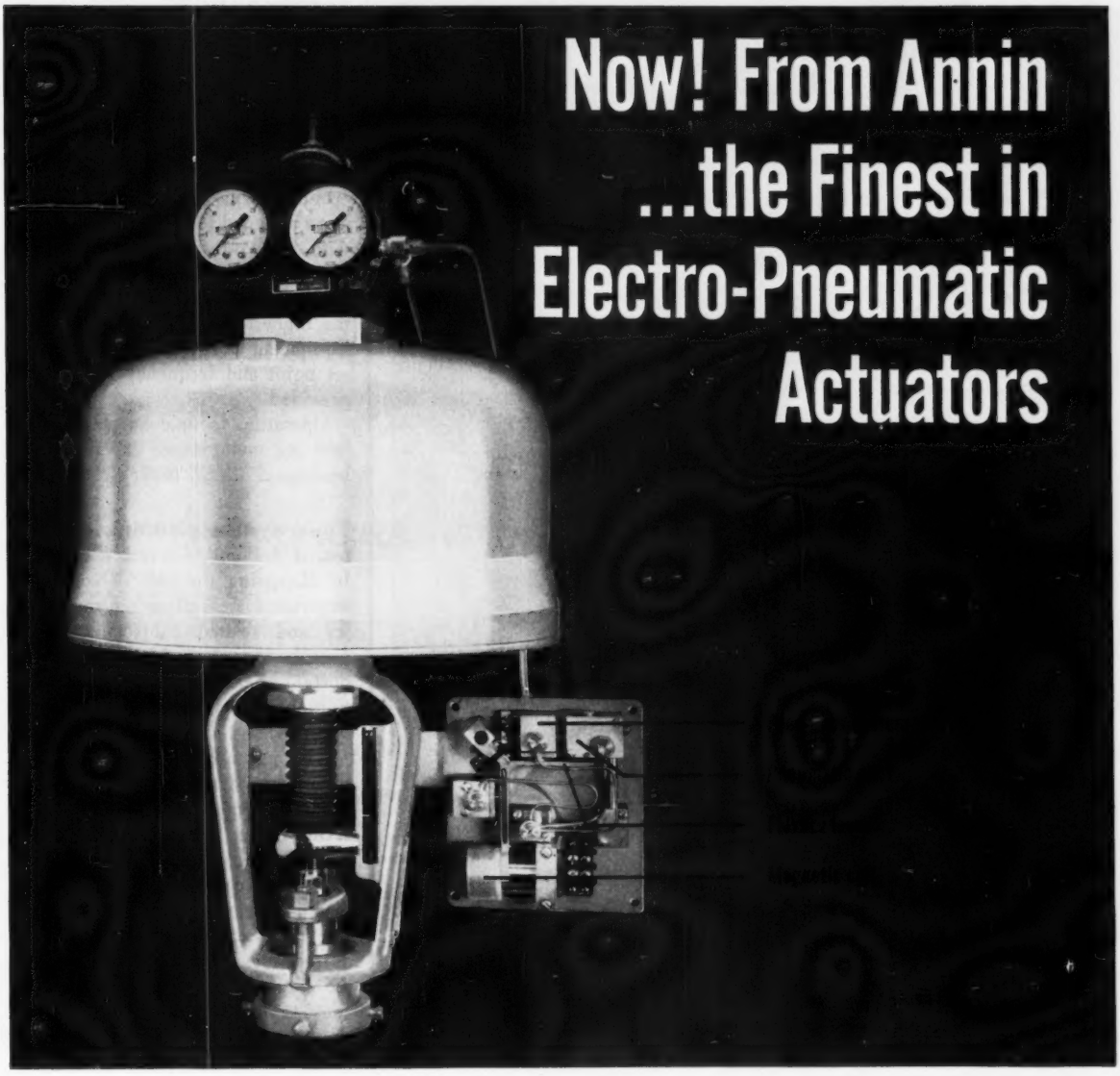

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## Technical briefs

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scheduled net input or output to or from the division over four major interconnections. Incremental loaders keep the generating plants loaded economically. Load increases are always assigned to the generating units with the lowest incremental cost at the time. Reductions in output are directed to the generators producing the highest incremental cost energy. Equipment for adjusting frequency set point and frequency bias is also provided.

Operation to date has been excellent and maintenance experience has been good. *AIEE paper CP-58-930*

**Power-system planning economics,** *A J Wood, General Electric Co*
In discussing the role of economics in power-system planning, many topics and related subjects must be considered. These include such important areas as the effect of inflation and the evaluation of the cost of system losses.

This paper is confined to a simple discussion of the place of economic evaluation in power-system planning. It illustrates, by a transmission-economics problem, that the economic choice between several alternatives is that plan which has the lowest present worth of all future revenue requirements. Further, it shows that the engineering economic evaluation consists basically of two relatively simple steps: estimating the annual costs and calculating the present worth of these annual revenue requirements. *AIEE paper CP-58-870*

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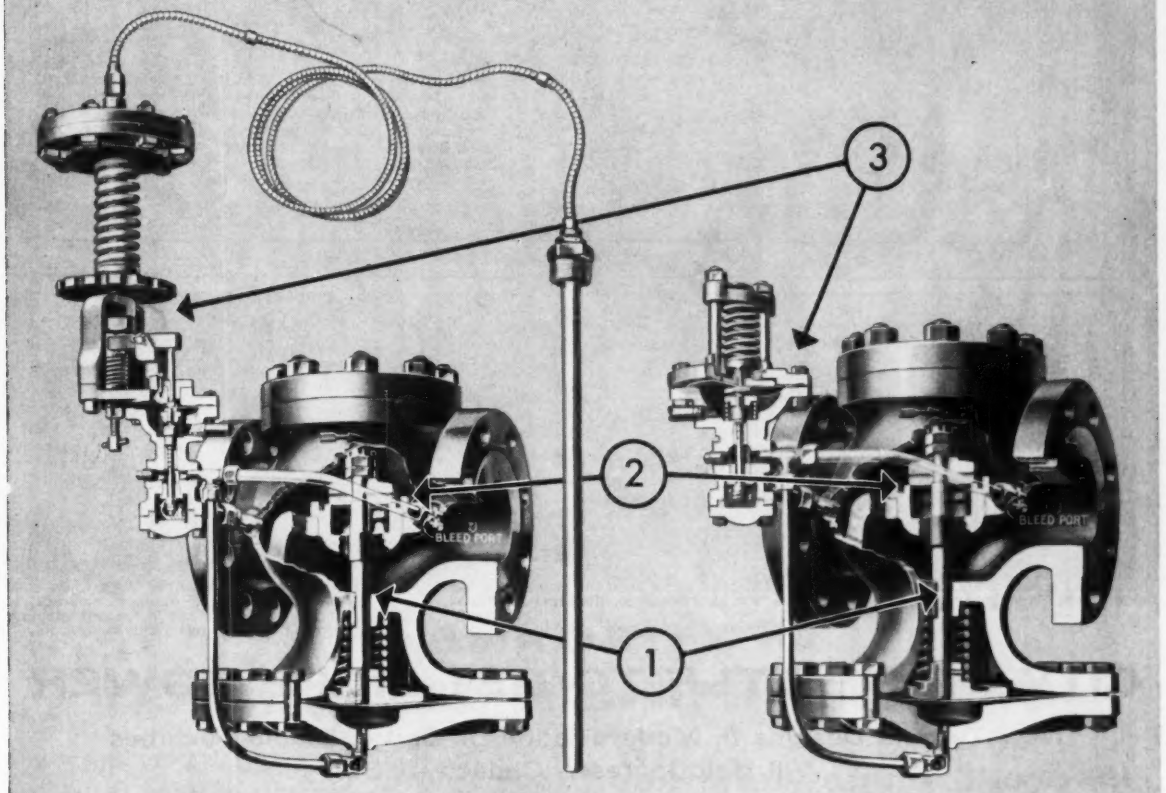
# 3 Tips for Low Maintenance in Automatic Regulating Valves




Spence ET124 Temperature Regulator

Spence ED Pressure Regulator

No engineer has to be told that downtime of regulating valves is costly—and a nuisance.

Nowadays the men who keep these valves operating want to make sure they aren't stuck with a maintenance headache for the life of their valves. That's why we are outlining this simple check list which covers three important features which keep maintenance costs down.

1. Stuffing boxes are probably the number one time consumer in valve maintenance. No matter how you figure it, repacking stuffing boxes is costly.

That's one reason Spence uses a "balanced" diaphragm construction which eliminates stuffing boxes. Simple stem guiding and large metal diaphragm operation reduce sticking and binding to a minimum.

2. Another problem is replacement of seats and discs when they've been cut by steam. Today you can forget about this problem entirely by insisting on an unconditional guarantee against wire-drawing. Spence, for instance, uses SECO Metal seats and discs and gives such a guarantee.

3. Any valve designed to control temperature and pressure within tight limits can be affected by dirt in the steam lines. You can't get a guarantee against this, but you can specify a valve that makes trouble shooting easy. Here's the tip:

Make sure your regulating valve is controlled by an external pilot. If trouble develops, it is easy to find out if it is in the pilot or the main valve with a simple test.

If the trouble is in the pilot, you can remove it without taking the main valve out of the line.

The quickest way to get the regulator working again is to install a spare pilot. This is easy—and in the Spence design it is not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves.

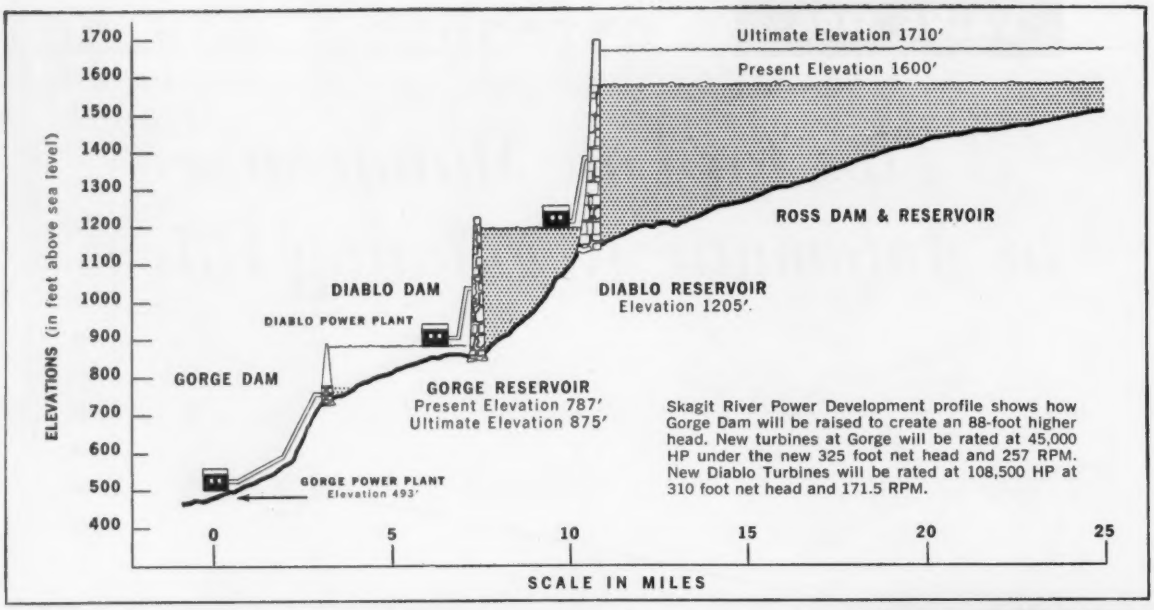
These maintenance advantages plus other advanced features are available in a wide range of Spence automatic regulating valves. For more information write for the Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
*Walden, New York*

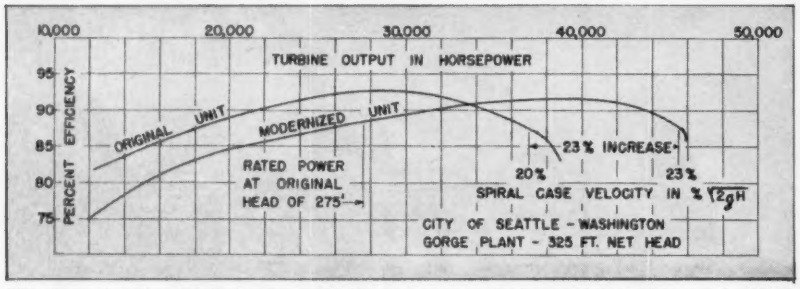
SE-144



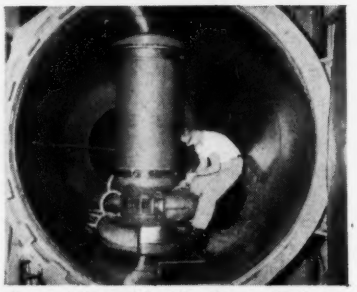
For more facts circle 261 on Reader Service Card, p 117




Skagit River Power Development profile shows how Gorge Dam will be raised to create an 88-foot higher head. New turbines at Gorge will be rated at 45,000 HP under the new 325 foot net head and 257 RPM. New Diablo Turbines will be rated at 108,500 HP at 310 foot net head and 171.5 RPM.




This shows the Laboratory Test performance (power stepped up for head and size), of the existing Gorge runners under the higher head and the new runner and gate design for the same conditions.



A complete model of the Gorge wheel case assembly, built to extreme accuracy, is shown being mounted in the test chamber of the high-head test stand in York, Pa.

# CITY OF SEATTLE TO GET MORE POWER

## New Turbine Designs in Modernization of Gorge, Diablo Facilities Will Help Increase Capacity 23%

As part of its program to get more power, Seattle, Washington's Skagit River development includes replacement of 35- and 22-year-old turbine runners at the Gorge and Diablo plants, and increasing the height of the Gorge Dam. Rebuilt vertical Francis runners and new wheel case accessories will give each unit 23% more capacity in the existing wheel cases.

Extensive model tests, conducted in the Allis-Chalmers Hydraulic Division laboratory's high-head test stand, proved that the proposed new runner and modified gate designs would provide the increased power with very little loss in efficiency. In addition, they would have improved cavitation characteristics to permit maintaining the original setting above tailwater elevation.

Research results such as these indicate Allis-Chalmers can provide substantial economies in both new and existing installations with higher turbine speeds and settings as well as smaller spiral cases and inlet valves. For further information, write Allis-Chalmers Manufacturing Co., Hydraulic Division, York, Pennsylvania.

**Since the Diablo units have gone into service, the city of Seattle advised that, prior to final testing, performance indicated that anticipated increase had been substantially met.**

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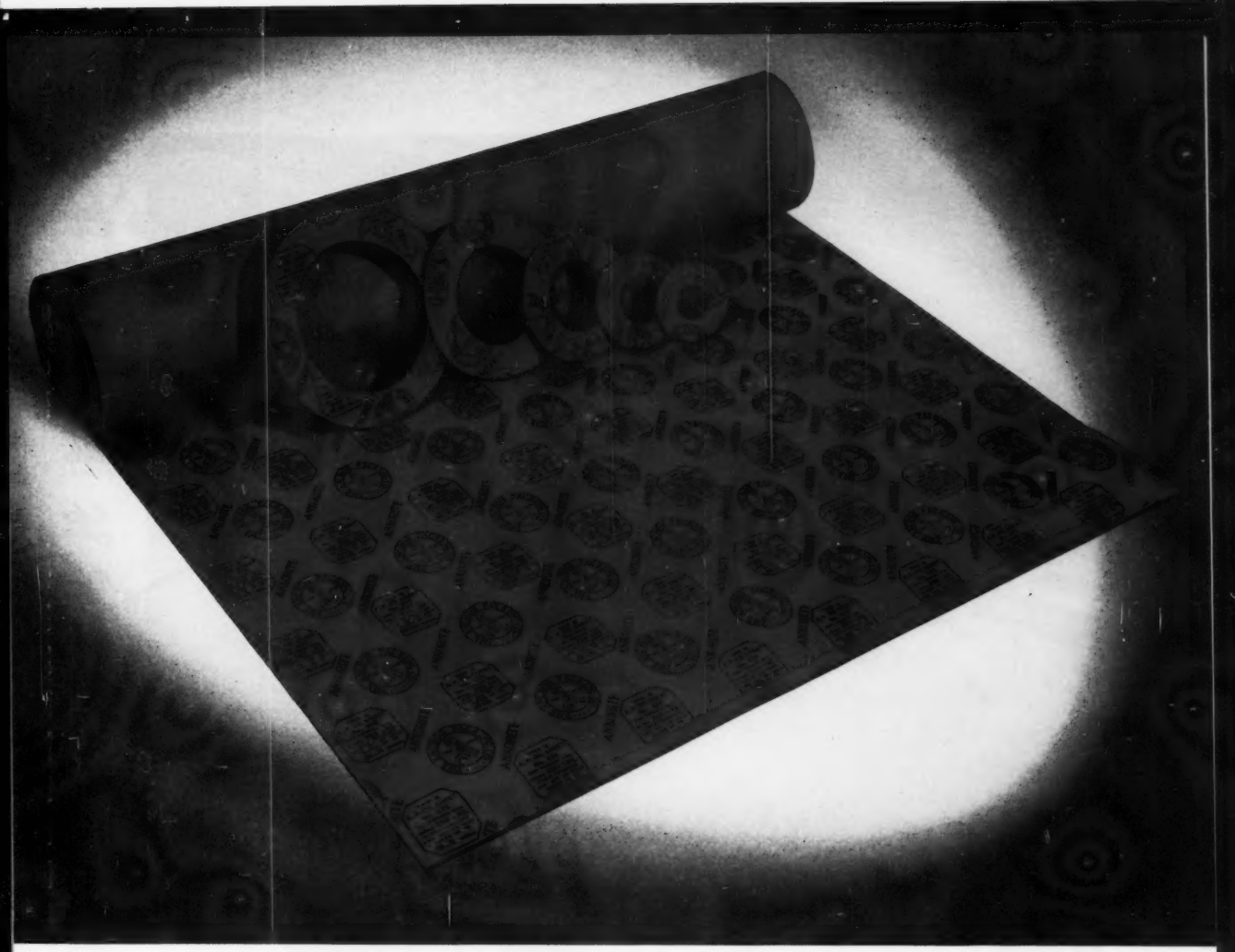
**ALLIS-CHALMERS**



For more facts circle 262 on Reader Service Card, p 117

For more facts circle 263 on Reader Service Card, p 117 ➤



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For further information on Green Label Red Sheet or other Anchor products, see your local Anchor Representative. He will gladly assist you. Or, contact the Anchor General Office in Philadelphia.

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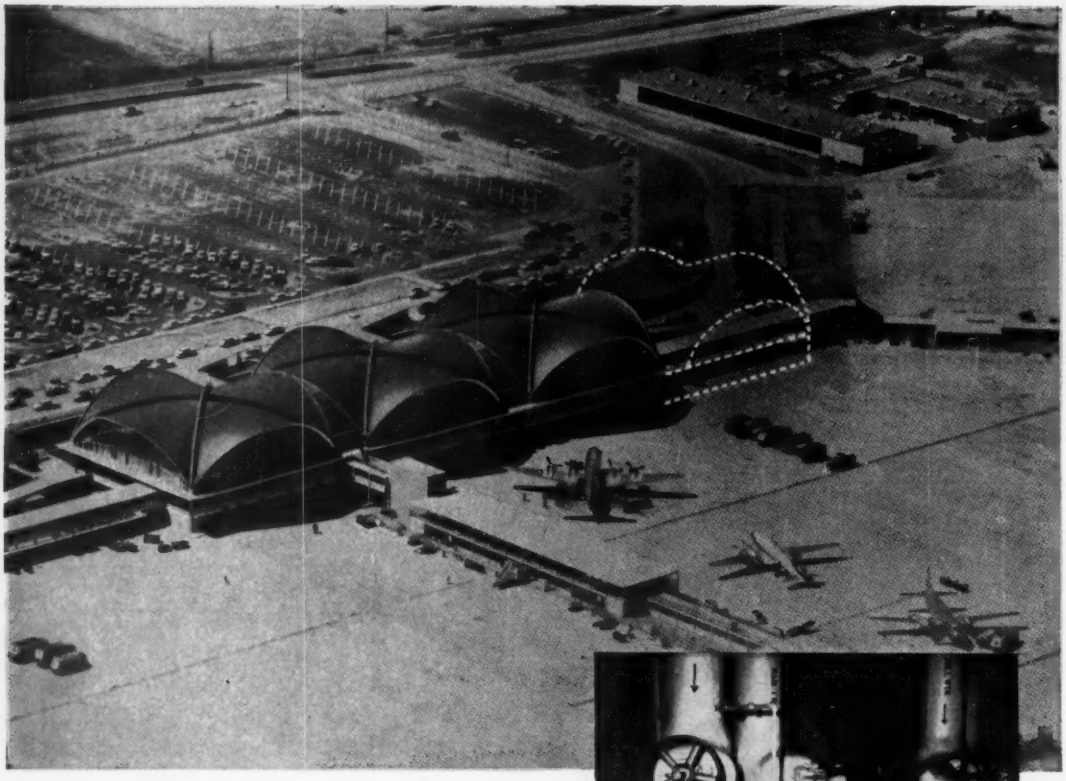

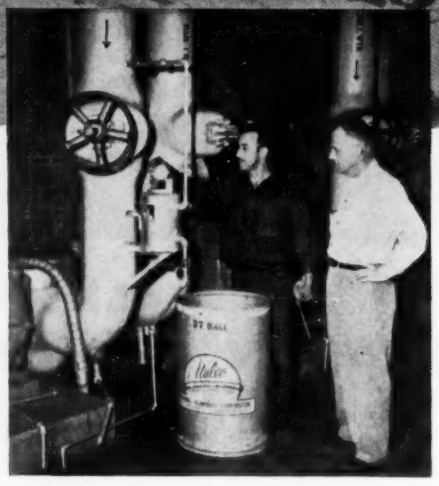

**Nalco protects vital services of new**

## LAMBERT-ST. LOUIS AIRPORT

Functional efficiency is usually one of the hallmarks of fine architecture and it is apparent throughout the new St. Louis Municipal Airport Terminal Buildings.

Vital service facilities are housed in a low, clean-lined power plant, well separated from the present main terminal building in anticipation of planned expansion to accommodate increasing airline traffic. The Nalco System protects boiler and cooling water systems by effectively controlling scale, corrosion and microbiological growth . . . a non-architectural supplement to functional efficiency in *any* plant where water is used.

Whether you are planning a new plant, or modernizing an old one, call on Nalco for water treatment chemicals and services that consistently produce outstanding results.

**Top photo: Unusual modern architecture of St. Louis Municipal Airport Terminal Building is expandable in any direction. New units (dotted lines), can be added readily when required. Services buildings, *upper right*, are built and equipped with future expansion in mind. *Photo by Lloyd Spainhower.***

**Lower photo: Nalco Chemicals and Services protect both boiler and cooling water systems at new St. Louis Airport. In this photo a Nalco cooling water treatment, supplied in ball briquette form, is being applied through the convenient Nalco feeder.**

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- **Study New Equipment** described in this issue starting on p 126. Circle numbers on card corresponding to items listed
- **Check New Literature** available this month beginning on p 118. To get your personal copies use the card below
- **Read advertisements** and note number listed under each ad. Circle ad numbers on card for complete details
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April 1959 issue — This card void after July 1, 1959

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# New free literature

### AIR CONDITIONING, HEATING AND VENTILATION

**101** **Packaged water chillers** for air-conditioning, industrial - cooling applications are covered in 16-p brochure 3325. Schematic wiring diagrams, selection charts are featured. American Standard, Industrial Div

**102** **Axial-flow fans** for corrosive atmospheres, elevated temperatures are topic of 16-p application guide AM-1001. Includes drive-arrangement table, corrosion-resistance guide. Westinghouse Electric Corp, Sturtevant Div

**103** **Sample specs** for forced-air heaters are given in 2-p bulletin EN-5900. Includes quick-reference data for complete line—400,000 to 2,000,000 Btu per hr output. Reznor Manufacturing Company

**104** **Air - conditioning** certification is described in 16-p bulletin. Discusses rating tests used in the industry program. Air-Conditioning, Refrigeration Institute

### MATERIALS HANDLING

**105** **Conveyor-elevators** are discussed in 62-p bulletin 358. Diagrams, drawings, photos show conveyors and accessories for all uses. Stephens-Adamson Mfg Co

**106** **Hoists and cranes,** motor- and hand-operated units, are subject of 8-p folder DH-28. American Chain & Cable Company, Inc

**107** **Conveyor-belt carriers** are topic of 20-p bulletin 355. On-the-job photos, diagrams, specs included. Stephens-Adamson Mfg Co

**108** **Car pullers** are described in 8-p bulletin 753. Photos illustrate sheaves, hooks, rollers and pullers. Stephens-Adamson Mfg Co

**109** **Magnetic separator,** induced-roll type, is discussed in bulletin 2091. Stearns Magnetic Products

**110** **Zipper bunker seals** are topic of 4-p bulletin 952. Units can help to cut down boilerhouse coal dust. Stephens-Adamson Mfg Co

### ELECTRICAL GENERATION, TRANSFORMATION AND CONVERSION

**111** **Substation transformers,** single and 3-phase units up to 10,000 kva, are subject of 8-p booklet CS-701. Construction features, standard and optional accessories are covered; illustrated with photos and diagrams. Kuhlman Electric Company

**112** **Selenium rectifiers** for ac to dc rectification in wide size range are covered in 10-p catalog. Data and specs are given for 1-sq-in. to 12x16-in. units. Rectifier circuits are illustrated and dc ratings included. Syntron Company

**113** **Synchronous generators,** high-speed units in ratings of 187 kva and larger, are topic of 2-p bulletin 2100-PDR-254. Electric Machinery Mfg Company

**114** **Vapor cooling** for transformers is discussed in 8-p booklet B-7602. Principles and practice are included. Westinghouse Electric Corporation

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### ELECTRICAL DISTRIBUTION AND PROTECTION

**115** **Electrical metallic tubing** is illustrated, described in 4-p bulletin EMT-958. Photos show tests made, tables list sizes, diameters, weights. Walker Brothers

**116** **Metal-enclosed bus** selection is aided by 20-p bulletin 2604-1A. Ratings, construction details are given for complete line of isolated-, nonsegregated-phase bus. I-T-E Circuit Breaker Company

**117** **Expansion fittings,** weathertight units available in ferrous and nonferrous metals for rigid conduit or EMT, are covered in 4-p bulletin 12. Spring City Electrical Mfg Co

**118** **Electrical potting** and encapsulating with room-temperature vulcanizing silicone rubber is described in bulletin CDS-170. General Electric Company, Silicone Products Dept

### ELECTRICAL APPLICATION

**119** **Motor controls** are topic of 84-p catalog 14. Product pictures, wiring diagrams, dimensional drawings illustrate size, weight and ratings info. Special sections cover replacement parts, heater tables. The Arrow-Hart & Hegeman Electric Company

**120** **Ac motor users' guide** B-2103-4 gives selection data on 1- to 200-hp units. The 12-p booklet explains design classes, current and torque values; gives frame-selection tables. Reliance Electric and Engineering Company

**121** **Single-phase motors** rated from ¾ to 20 hp are listed in 4-p bulletin 470-B. Robbins & Myers, Inc, Motor Div

**122** **Repair and replacement** service for electric motors and generators is described in 4-p bulletin 29-1. Century Electric Company

**123** **Motor application guide** 370-A has 16 pp, lists nine major factors in motor selection. Polyphase, single-phase and dc motor charts detail typical equipment. Century Electric Company

**124** **Right-angle gearmotors** are topic of 4-p bulletin 3050. Engineering info is given on units rated 1/3 to 30 hp, single reduction, with speeds of 23 to 280 rpm. The Louis Allis Co

**125** **Emergency lighting units** provide instant, automatic light in case of power failure—8-p catalog gives details. Electric Cord Company

**126** **Silicon-rectifier chargers** for standby batteries are detailed in 4-p bulletin 6258. Info is given on models for 1- to 400-amp batteries. The Electric Storage Battery Company, Exide Industrial Div

**127** **Portable tool tester** is subject of 4-p bulletin. Unit checks for open equipment ground, faulty ground or short circuits; it will test any tool or appliance in its amp range. Pow-R-Safe Inc

### HEAT EXCHANGE

**128** **Instantaneous heaters** with large steam-inlet area are discussed in 24-p bulletin 304.4K1. Includes 17 pages of selection tables, charts, piping diagrams. American-Standard, Industrial Div

**129** **Fuel-oil heaters** used on suction side of pumps for heating viscous fluids are topic of 8-p bulletin 585. Tank-suction and line type heaters are covered. Brown Fintube Company

continued

April 1959 issue

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NEW FREE LITERATURE continued..... circle key numbers, page 117, for your copies

### INSTRUMENTATION

**130** **Differential-pressure transmitter** is topic of 2-p bulletin WG-1824-A. Applications, operation, construction are covered. Yarnall-Waring Company

**131** **Manometers** of new design are among units illustrated in 12-p catalog. Includes design data. Trimount Instrument Company

**132** **Temperature - millivolt** conversion tables for thermocouples are listed on 4-p chart. Thermo Electric Co, Inc

**133** **Temperature controllers,** electronic units for industrial heating and cooling operations, are described in 4-p specification S1010-6. Minneapolis-Honeywell Regulator Co, Industrial Div

**134** **Instrumentation literature** available is listed in 24-p index G1a. Product, technological and application bulletins are included. Minneapolis - Honeywell Regulator Co, Industrial Div

**135** **Automated system** for continuous chemical analysis is described in 8-p brochure. Technicon Controls, Inc

**136** **Closed-circuit TV** equipment is topic of 8-p bulletin 6-103. Photos, diagrams show applications; illustrate actual systems. Cohu Electronics, Inc, Kin Tel Div

**137** **Ac electronic voltmeter** is topic of 2-p bulletin 7004A. Consolidated Electrodynamics Corp

**138** **True-rms voltmeter** is topic of 2-p data sheet 7003A. Consolidated Electrodynamics Corp

**139** **Receiver** for temperature, pH and conductivity measurement and closed - circuit telemetering is subject of 8-p bulletin OE-1003. Hagan Chemicals & Controls, Inc, Controls Div

**140** **General-purpose computer** is described in 6-p folder S-526R1. Specs, features are given, major components illustrated. Royal McBee Corporation, Data Processing Div

### WELDING

**141** **Welding equipment** and industrial regulators are discussed in 24-p brochure. Cross sections help evaluate important oxyacetylene equipment design features. Modern Engineering Co

**142** **High-tensile electrodes** are topic of 2-p data sheet 7205.1. The Lincoln Electric Company

**143** **"Welding News,"** a publication for users of bronze welding electrodes, features info on overlaying steel-pipe expander rings. Ampco Metal, Inc

### MAINTENANCE

**144** **Vibration-control** mountings and materials available are listed and described in 4-p bulletin IND-11. Book covers five methods. Vibration Mountings, Inc

**145** **Making your own** machine and repair parts is topic of 24 - p booklet. Care and trouble-shooting for machines and equipment, machining and welding techniques are covered. La Salle Steel Company

**146** **Flashing insulation** to structural metal is topic of spec sheet F-3-A. Field problem, service requirement, one solution are described. Benjamin Foster Co

**147** **Corrosion prevention** on a long-term basis is topic of 4-p bulletin 93XG. Metallizing Engineering Co, Inc

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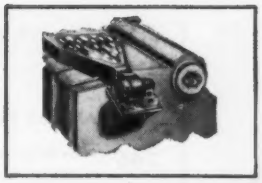

*Designed to comply with or exceed Government Specification MIL-B-170958. Either left or righthand units can be supplied.*

Capacities to
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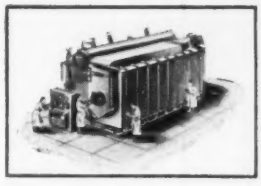
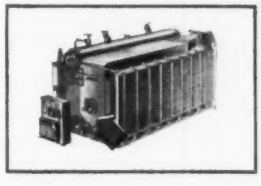
lbs. per hour

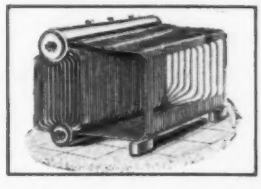
*Completely plant assembled and factory fire tested with auxiliary equipment for capacity, efficiency and performance.*



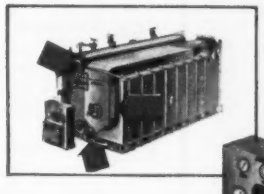
*Rotary cup or steam assisted burners. Multiple burners where required. Burners for oil, gas, or both available on all units.*



*Tangent tube, waterwall furnace, all riser elements, discharge directly to steam drum. Drums extend both ends for maximum volume and releasing area.*



*Adequate inspection openings in casing. Refractory lined access door. Two manholes in each drum on sizes over 15,000 lbs. per hr.*

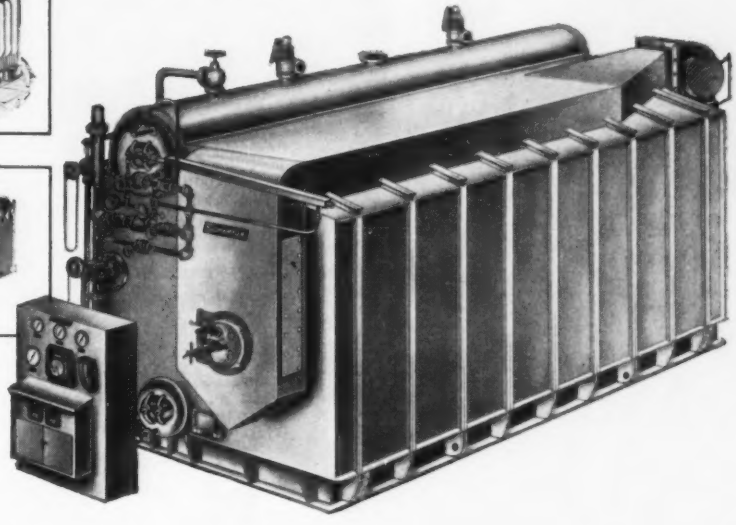


# NEVER BEFORE SO MUCH IN A PACKAGE BOILER

Whether you are building, modernizing, or expanding, *so many* features contributing to low cost steam demand your consideration.

Completely integrated units combining the basic D type boiler tube arrangement with the most modern features of boiler design, Type D Superior Steam Generators are engineered for efficient firing with oil, gas or both. Performance rated for high availability and long life, with continuous steaming capacities to 61,000 lbs. per hour, plus overloads, they may be economically combined in batteries for much higher capacities. Each Type D Superior Steam Generator is completely assembled and fire tested at the factory. They may be transported by truck, rail or boat.

There's no guesswork about Superior Steam Generators. They are designed, built and tested by specialists in packaged boilers exclusively.



For complete details and dimensions, write today for your copy of Catalog 11W

Specialists in PACKAGED BOILERS... exclusively

**SUPERIOR COMBUSTION INDUSTRIES INC.**
**TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.**

SUPERIOR
STEAM GENERATORS

The design work on all these new substations is going to be hard to handle with our present force.

Of course! They have enough to do handling routine duties. Why don't you call in PIONEER?

GIVE YOUR NON-ROUTINE OPERATIONS TO PIONEER

**Design and Consulting Engineering Services**

Pioneer has specialized in designing power plants for 57 years. It offers design service for fossil fuel, hydro and atomic plants. It will also assist in forecasting load growth, in site selection, in purchasing and expediting of equipment and in supervising construction. Pioneer's other services include substation, transmission and distribution studies and design.

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**Corporate Services**

Pioneer's services in corporate matters include business and management engineering advice, financial, accounting and tax counsel and insurance and pension plans and programming. It maintains a complete stock transfer, ledger and dividend disbursement service.

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On your letterhead, write for 40-page booklet, "Pioneering New Horizons in Power". Describes, illustrates Pioneer's engineering services, and corporate services, from financing to operation.

57 YEARS

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231 South La Salle Street
Chicago 4, Illinois


## Free literature

Begins on page 118

### MECHANICAL POWER TRANSMISSION

**148** **V-belt drives** that are smaller, cheaper, lighter are covered in 44-p bulletin A-695. Includes photos, engineering drawings and tables. Dodge Manufacturing Corporation

**149** **Variable-speed drives** providing precise, adjustable output speeds from a constant-rpm motor source are covered in 8-p bulletin G-5812. Reliance Electric and Engineering Company, Reeves Pulley Company Div

### PUMPS

**150** **Vacuum pump** that steals pure samples from tanks, drums, crankcases is described in 4-p bulletin. W & W Manufacturing Company

**151** **Metering pumps** are subject of 6-p folder 900. Photos, diagrams illustrate features. Hills-McCanna Company

**152** **Pumps** for metering chemicals in minute volumes against pressure are described in 4-p bulletin 1257-1. Includes info on chromatographic analysis. Milton Roy Company

### STEAM GENERATION

**153** **Boilers** and accessories are described in 20-p catalog SB-60. Cross sections of major products show design and construction. Erie City Iron Works

**154** **Packaged** automatic hot-water boilers are topic of 8-p bulletin 1251. Units from 500,000 to 20,000,000 Btu per hr are included. Orr & Sembower, Inc

**155** **Vapor-drum boilers** are topic of 16-p bulletin 491. Recent industrial applications are shown in on-the-job photos. Vapor Heating Corporation

**156** **Desuperheater,** carburetor type, is described in 4-p bulletin 1056. Range of control is explained. Blaw-Knox Company, Copes-Vulcan Div

### VALVES, PIPING, FITTINGS AND SPECIALTIES

**157** **Valves** for oil, water or air service; manual, foot-operated and solenoid units, are described in 20-p catalog 59-60. Overall pressure range is vacuum to 10,000 psi. Barksdale Valves

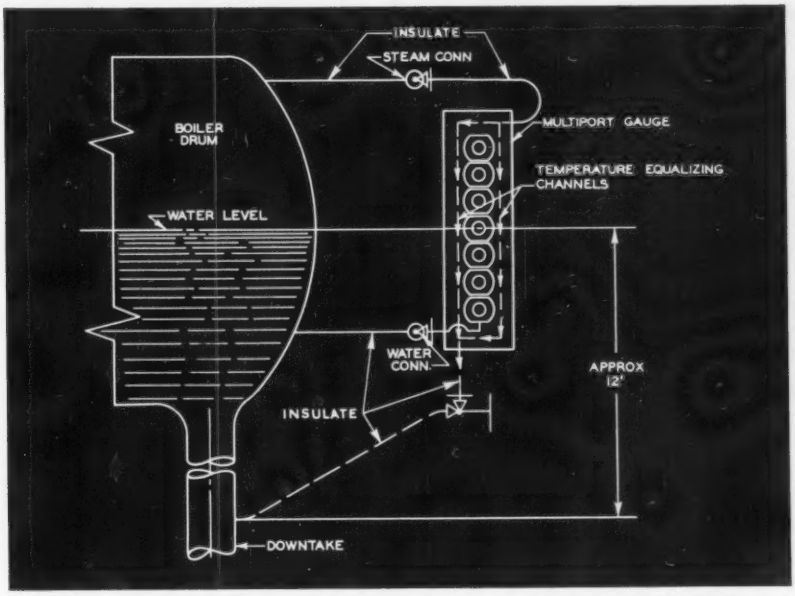
**158** **Nonreturn valve** to protect boiler is topic of 8-p bulletin S-2-B. Drawings, diagrams illustrate single-acting unit. Golden-Anderson Valve Specialty Company

continued

Diamond

# Temperature Equalizing MULTI-PORT GAUGE*

## Improves Accuracy of Water Level Indication at High Operating Pressures




Diagramatic illustration of new Diamond Temperature-Equalizing Multi-Port Gauge installation.

By a simple reliable means the Diamond Temperature Equalizing Multi-Port Gauge* effectively reduces error in gauge level reading at high operating pressures.

Gauge error (resulting from the gauge temperature being lower than boiler saturation temperature) is substantially avoided by introducing supplementary gauge heating in the form of steam condensing channels. These channels are parallel to the gauge water level channel as illustrated, and serve to heat the gauge level channel by direct conduction of heat from condensing steam through the gauge body itself. No external source of energy or control is required. The heating channels have a natural circulation system independent of the gauge level channel so that no faulty operation can occur under any circumstance.

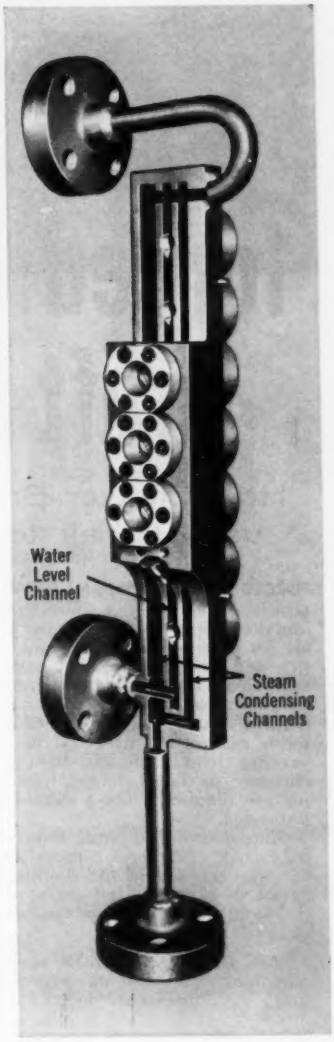
Ask your local Diamond office or write directly to Lancaster, Ohio for Form 2150 for further information.

*Patent Applied For.

**DIAMOND POWER SPECIALTY CORP.** 8274

**LANCASTER, OHIO**

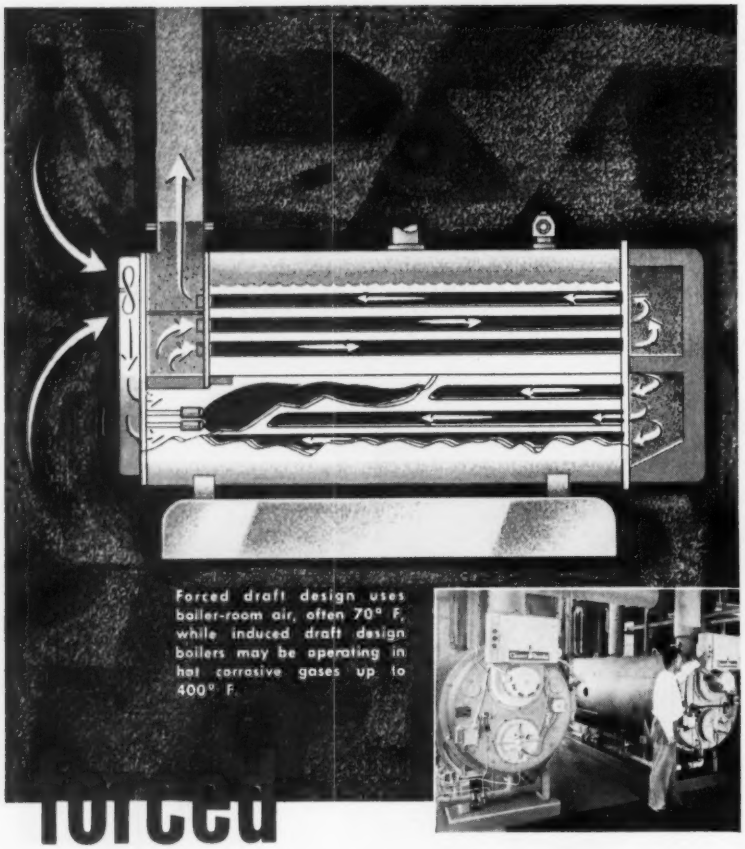
DIAMOND SPECIALTY LIMITED—Windsor, Ontario




Cut-away sections illustrate independent gauge body heating channels of the new Diamond Temperature-Equalizing Multi-Port Gauge.



For more facts circle 267 on Reader Service Card, p 117



Forced draft design uses boiler-room air, often 70° F, while induced draft design boilers may be operating in hot corrosive gases up to 400° F.

# forced draft design:

## How Cleaver-Brooks packaged boilers use cool air to heat more efficiently

**FORCED DRAFT DESIGN PROVIDES** positive draft with a vibration-free fan, delivering cool, clean boiler room air for combustion at constant density and volume. Efficient combustion, clean fire and stable flame are assured through air-fuel ratios automatically controlled and balanced for a modulating fire, and to meet varying load demands. No high chimney or large diameter breeching are required; only a simple vent is needed.

Since the forced draft fan moves only cool, clean boiler room air, it is never exposed to the sooting and corrosive effects of hot gases; it requires little maintenance and is lower in initial cost.

**4-PASS FIRE TUBE DESIGN** squeezes maximum heat out of every fuel unit . . . maintains high flue-gas velocity . . . assures optimum heat transfer.

**UPDRAFT CONSTRUCTION** with low furnace keeps hottest gases well below water level for safe operation.

**5-SQ. FT. OF HEATING SURFACE** per boiler hp for top heat transfer, prolongs boiler life, assures greater efficiency and lower maintenance.

This exclusive combination of Design Standards is the key to the superiority of Cleaver-Brooks packaged boilers — 15 to 600 hp, 19 sizes, 130 models; steam or hot water; oil, gas or combination oil/gas fired; parts and service available anywhere in the U.S. and Canada.

For details, contact our representative or write Cleaver-Brooks Company, Dept. D, 301 E. Keefe Avenue, Milwaukee 12, Wisconsin.

**Cleaver Brooks**

ORIGINATOR AND LARGEST PRODUCER OF PACKAGED BOILERS


## Free literature

Begins on page 118

**159** **Selector** helps find right size gage and valve for various uses. Jerguson Gage & Valve Co

**160** **Ductile iron products**—pipe, tubing, casing, fittings—are shown in 36-p catalog. Grades, specs, dimensions and weights, applications are listed. American Cast Iron Pipe Company

**161** **Insulation** for pipe and equipment, effective for temperatures to 1800 F, are covered in 8-p brochure 1-IN-759. Owens-Corning Fiberglas Corporation

**162** **Drain pipes** with porous walls are detailed in 4-p bulletin. Walker Poroswall Pipe Co

**163** **Couplings and fittings** for all types of industrial rubber hose are subject of 8-p bulletin 34. Hose Accessories Co

**164** **Coating** over mastic or jacketing on insulated piping and equipment is topic of spec sheet C-2-B. Shows typical problem, one solution. Benjamin Foster Company

### WATER TREATMENT

**165** **Sodium sulfite use** for removing oxygen from boiler feedwater is topic of new bulletin. Monsanto Chemical Company, Inorganic Chemicals Div

★ EDITOR'S NOTE: *The following bulletins may be requested directly from manufacturer. Write on company letterhead to addresses below*

★ **Industrial spray nozzles** are covered in 32-p catalog 59. Specific details of flow, spray patterns for each nozzle are illustrated. Wm Steinen Mfg Co, Industrial Nozzle Div, 45 Bruen St, Newark 5, N. J.

★ **Air - conditioning** zone - control cabinets are described and illustrated in 20-p bulletin AC-220. Tables, curves and sketches cover selection, data, dimensions, ratings. Buffalo Forge Company, Buffalo 5, N. Y.

★ **Condenser handbook** has 32 pp, gives simple methods of calculating steam-condenser performance. Curves, charts make up most of book. C H Wheeler Manufacturing Company, 19th & Lehigh Ave, Philadelphia 32, Pa.

★ **Refractories** are covered in set of three 4-p bulletins. Firebrick cement, plastic firebrick, castables are covered. Botfield Refractories Company, Swanson & Clymer St, Philadelphia 47, Pa.

# so National rebuilds and ships motor in 4½ days

FAILURE of this slip-ring induction motor threatened a shutdown of service. So the owner shipped the motor to National Electric Coil — to get it rebuilt fast and rebuilt right.

In just 4½ working days, here's what National did: *designed* and built both stator and rotor coils, rebabbitted the bearings, turned the slip rings, repaired stator laminations, rewound stator and rotor, dynamically balanced the rotor, performed complete checkout testing, crated, loaded and started the motor on its return trip!

For service when you need it, it's wise to have this responsible, competent organization on your electrical machinery team. Call or write for full information.

McGRAW EDISON

## NATIONAL ELECTRIC COIL

*Division of McGraw-Edison Company*

**COLUMBUS 16, OHIO,**

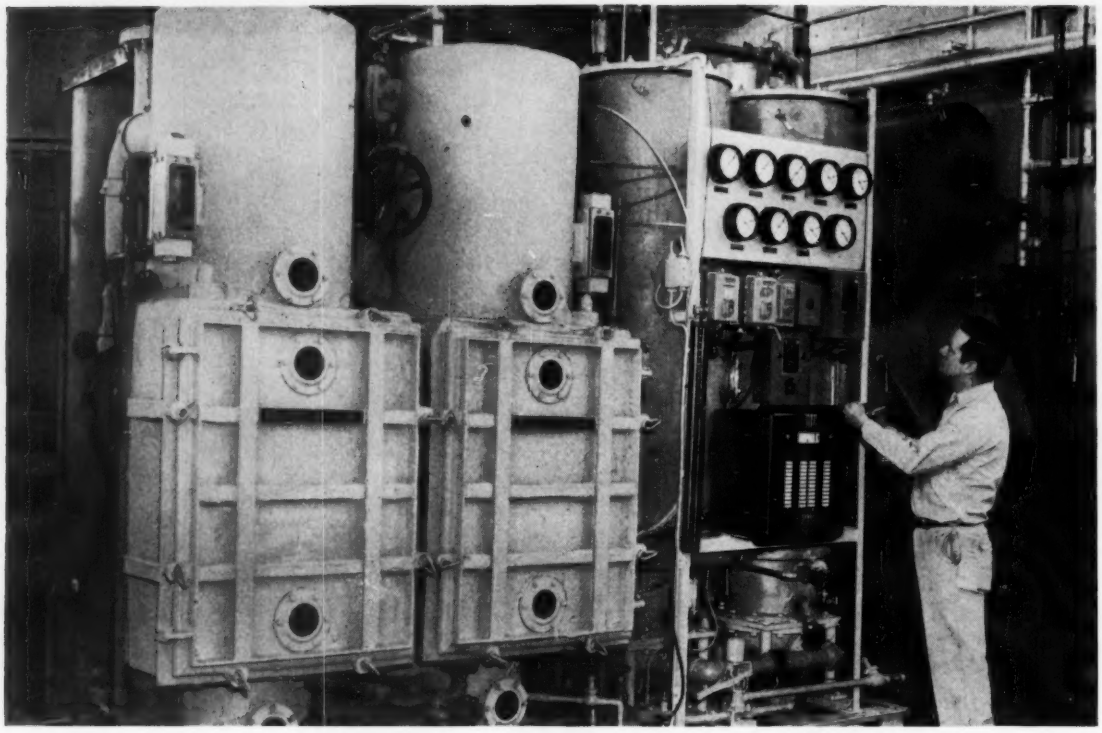
ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS • REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

EXCLUSIVE

# Equipment design of the month

On this page each month you will see the wraps taken off a significant new product at least 30 days before it's released to any other publication, and before it's advertised anywhere

By STEVE ELONKA
Associate Editor



## Here's the latest in packaged salt-water distillers

This packaged vapor-compression distilling plant turns the ocean into fresh water, and does it efficiently.

Designed for military use this unit is a combination basket, jet compression, flash evaporator. Rated capacity is 10,000 gallons per day, and unit produces not less than 90 gallons of distillate per gallon of fuel. Being packaged, it can be air lifted to remote regions.

Developed by Emhart Mfg Co, Maxim Division, Hartford, Conn., it consists of one double-effect basket unit with a steam-jet compressor and eight flash stages. Unit is complete with brine, distillate and chest drain pumps and other accessories, and all piping.

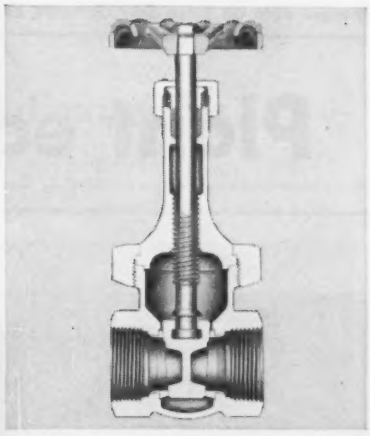
Plant has an overload capacity of over 25%. Distillate purity is better than 0.25 grains per gallon of sea salts. Steam pressure used is 140 psig. Plant is 10 ft 6 in. long, 8 ft high and weighs 12,000 lb. U.S. Navy will soon conduct tests on this unit at Port Hueneme, California.

Unique design feature is materials used. Basket-effect shells and basket heating sections are monel; flash storages are Fiberglass. Distiller condenser has steel shell, aluminum tubes and tube sheets, cast iron heads. Flash condenser has aluminum tubes, tube sheets and supports. Jet compressor is cast iron. Bronze components have been kept to minimum and are fitted only on systems downstream of the aluminum parts to prevent copper corrosion attack on the aluminum.

Among advantages claimed are: (1) High efficiency over long periods, making it unnecessary to shut down frequently for cleaning. (2) Compact design and light weight, making unit adaptable for air transportation. (3) Use of a minimum amount of critical materials, making unit suitable for mass production for both military and industrial use. Distiller operates on a self-contained thermodynamic cycle, dependent only on a power source.

**For additional information, circle No. 93 on reader service card, page 117**

**Expanded-type body rings.** Made from Crane Exelloy—a 12% chromium stainless steel. Provide a hard surface that resists abrasive damage, indentation and scoring by foreign matter. Rings are rolled in, can't work loose. Seating wear is taken by easy-to-replace bronze disc.



**Quality in every detail** inside and out. In rising and non-rising stem patterns—¼ to 3 inches—screwed ends. Working pressures: 200 lb. steam, 550° F.; 400 lb. non-shock cold water, oil, gas and air, 150° F.

**Cylindrical body shape.** Proved on high-pressure steel valves. Increases body strength without adding bulk. Distributes pressure uniformly. Reinforces seating area against distortion and chance for leaks.

# 12% chromium stainless steel seat rings make Crane 200-pound bronze gates last longer

Here is a close-up of Crane quality that shows you why these 200-pound bronze gate valves perform more dependably than ordinary bronze valves, with less maintenance.

For example, instead of integrally cast seats, they have long-wearing 12% chromium stainless steel body rings. Rings are rolled in... can't work loose in service. This also prevents leakage around rings. The quickly replaceable bronze disc takes normal seating wear.

Crane 200-pound bronze valves are competitively priced with bronze valves which do not have these and other important features. Why pay for less than Crane offers you? For complete facts, see your Crane Representative.

**Write for Circular** AD-2285. Gives complete technical data on both rising and non-rising stem patterns.

## CRANE® VALVES & FITTINGS

**PIPE • PLUMBING • HEATING • AIR CONDITIONING**

*Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas*

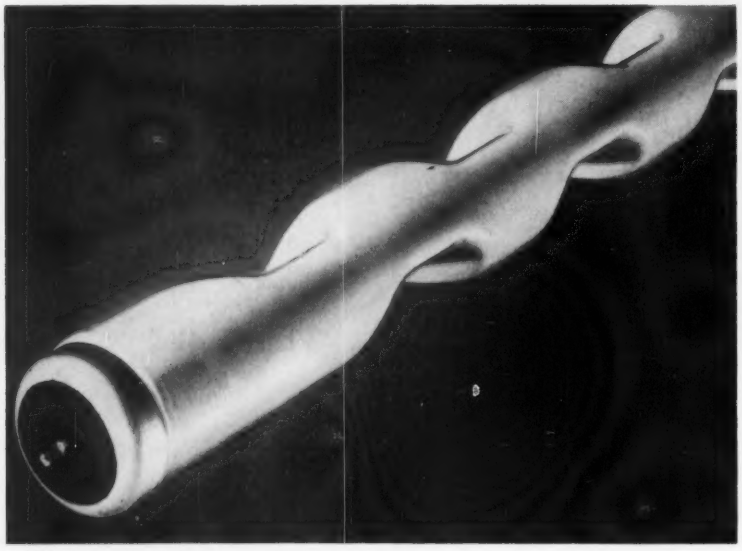
*In Canada: Crane, Limited, 1170 Beaver Hall Square, Montreal, Que.*



**For more facts circle 270 on Reader Service Card, p 117**

For more data on these developments, circle key numbers on reader service card, p 117

# Plant equipment news . . . Your



**STAGGERED GROOVES** mean that arc has a longer path to travel, producing more light. Cross-section, *right*, shows how grooves bring phosphor closer to the arc. Bulges also provide cool spots on the tube to help control pressure of mercury vapor

## Alternating grooves are key to new look in light

1 • GE's most powerful fluorescent lamp to date boasts an output of 15% more light than previous models, coupled with only a 7% increase in electricity consumed. Additional light produced by one 8-ft *Power-Groove* tube is said to be worth $2.60 a year to the user.

Increase comes from a new tube design using forty 3-in. crescent-shaped grooves alternating on opposite sides of a 96-in. tube. Grooves bring part of the inside coating of phosphor closer to arc stream, where it is stimulated into greater activity. And curved path means that in an 8-ft tube, the arc stream has an extra foot to travel—equal to arc in a straight 9-ft lamp, maker states.

An additional advantage is tube's light weight. New configuration permits the use of thinner glass, so weight is almost 25% less than in previous models.

Units will operate reliably in existing fixtures. In new installations, with ballasts and fixtures keyed to them, lamps will achieve the full 15% light-output gain—15,000 lumens at 215 watts, an efficiency of 70 lumens per watt. Previous best for this type lamp was 65 lumens per watt.

Initial units will be 8-ft long, with 4- and 6-ft models to follow. The 175-volt lamp has an economic life of 5000 hr. List price, $6.50 per lamp, remains the same.—General Electric Company, Large Lamp Dept

## Low-temperature-curing silicone resin needs 100 C less heat

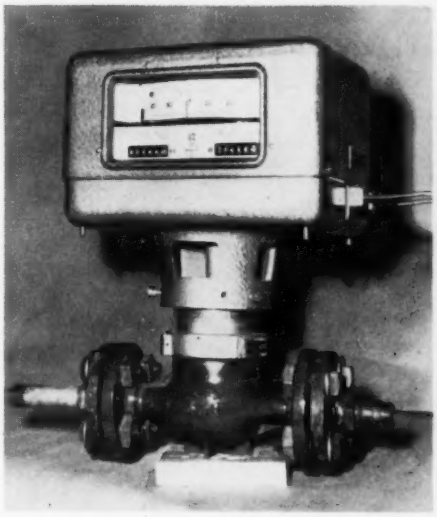
2 • With the introduction of *XR-622*, electrical shops lacking high-temperature curing ovens can enter the silicone field. Where conventional varnishes must be set at 200 to 250 C for top performance, this new thermo-setting silicone resin will cure completely after only 8 to 16 hours in a 150-C oven. Class H impregnation is possible with Class B processing equipment, according to the maker.

Shops and factories already equipped with high-temperature ovens can use the new varnish to reduce curing time. At 250 C, it will cure in 20% of the time taken by a conventional high-temperature varnish.

Because of its good dielectric life, *XR-622* is recommended for use in varnishing or coating electric coils, armatures, stators in electric motors, generators and transformers for high-temperature or heavy-duty service. It is useful as a final dip for Class B equipment, for extra moisture and chemical protection. Good wettability is a feature—the resin penetrates well into all interstices of equipment being dipped.—Union Carbide Corporation, Silicones Div

# information center for new products and materials

## Heat-pump output metered in Btu

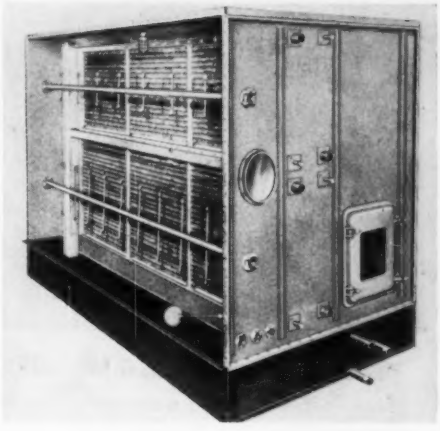


**3** • Now tenants can be charged for heating and cooling supplied from a central heat-pump installation in exact proportion to use. A single Btu meter—the first mechanical unit developed exclusively for the heat pump—measures precise amount of heat absorption or cooling used, at points where water enters and leaves tenant's space. Designed for shopping centers, office buildings and labs, meter is also adaptable to many kinds of process work.

Assembly includes a liquid meter, integrator and two temperature-sensing bulbs. One bulb is placed in supply line, the other in return line. Integrator mechanically multiplies the difference in water temperature between lines by net weight of water flow. Result in Btu is shown cumulatively on a digital counter on face of meter —one dial shows heating, another cooling.

Unit features automatic changeover from heating to cooling by means of an electric switch. The meters can also be used with conventional heating and cooling equipment—two units are needed for the two separate systems.—Air Conditioning Equipment Corp

## Dehumidifiers meet all-air system needs

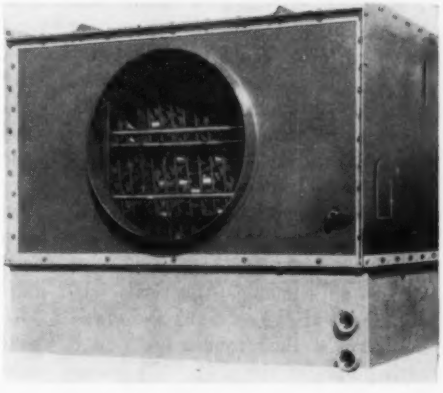


**4** • Blow-through units are designed to meet the most stringent requirements of medium- and high-velocity all-air systems in multistory buildings. Sprayed-coil dehumidifiers are available in low- and high-pressure models, in 127 sizes from 2310 to 45,900 cfm for operation up to 9-in. wg static pressure.

The heavy-duty units have a casing designed to be air- and watertight in single-zone, multizone or dual-duct blow-through systems. Both ends of cooling coils are sealed inside casing to eliminate sweating and dripping due to condensation. Direct-expansion or chilled-water coils are available, and are easily accessible for maintenance, according to manufacturer.

A separate section contains removable-blade inlet louvers to prevent spray from backlashing when air goes through bypass duct on multizone systems.—American-Standard, Industrial Div

## Plastic air washers cut down maintenance



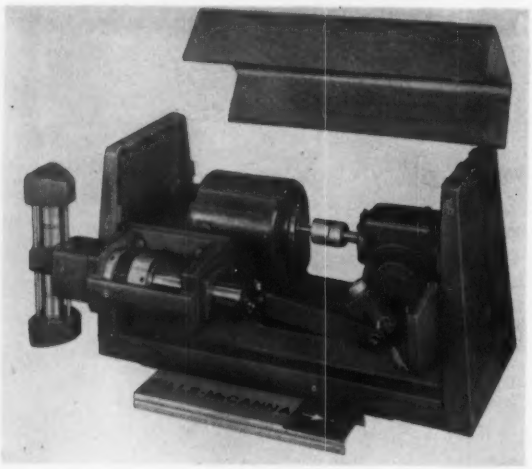
**5** • Rigid polyvinyl-chloride air washers will clean 96 to 99% of contaminants instantaneously soluble in water, such as chromic acid, sulfuric acid, caustics. Except for an external metal base, entire unit is made of plastic, resulting in a smooth, nonporous surface with less resistance to air flow. There is less material buildup on packing rings and structural surfaces, and ring bed won't absorb water or contaminated material, maker states.

Air washers are available in capacities from 1000 to 54,000 cfm. One economy feature is low water consumption—approximately one gal per 1000 ft of air handled. Rooftop installations need no extra support, since plastic washers weigh only one-sixth as much as similar units made of steel.—Industrial Plastic Fabricators, Inc.

For more data on these developments, circle key numbers on reader service card, p 117

# More **equipment news**

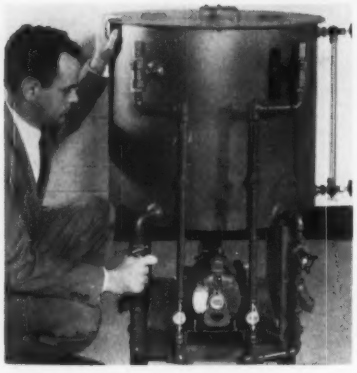
For more data on these developments, circle key numbers on Reader Service Card, p 117



## Revamped metering pump features performance and economy

**6** • Streamlined, functional safety shield covers a compact arrangement of components in this redesigned proportioning and metering pump. Payloads are accurately delivered through a range from a fraction to 1030 gph per feed, according to the manufacturer.

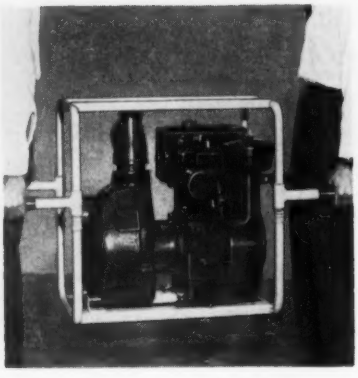
Four new models are look-alikes and have interchangeable parts to cut down inventory and maintenance problems. Units are powered by standard NEMA foot-mounted motors with separate speed reducers. Drive mechanism is also improved: connecting rods extend only nine degrees from axis of plunger, holding the eccentric load to a minimum. Check-valve assembly has a straight-through flow. Manual and automatic "in-motion" stroke adjustment is optional.—Hills-McCanna Company



## Packaged system available for chemical-feed pumps

**7** • Customers can now obtain both *Series 100* proportioning pumps and standard feeder tanks in a single order. Packaged-system arrangements are said to provide economy and convenience, with one phase of installation piping completely eliminated.

Pumps are controlled-capacity units. Capacities range from .65 to 13.10 gph at pressures of 1000 psi in the simplex model. Accurate screw type stroke adjustments, spherical self-aligning bearings on crank and cross-head, nylon dust covers are design high points of the units.—American Meter Company, Pump Div



## Lightweight heavy-duty pump handles up to 22,000 gph

**8** • Self-priming pump is powered by a 9-hp engine, standard-equipped with exhaust-valve rotator. It weighs only 145 lb. Applications include pumping water from excavations, elevator shafts and manholes as well as general low-cost utility pumping.

Simplified design eliminates troublesome check and suction-hose foot valves and all paper gaskets. Impeller wear adjustment can be accomplished externally without dismantling. *Model 30-T* comes with convenient carrying handles, mounted on wheels or in a wrap-around protective frame, above. —Hale Fire Pump Company

## Compact triplex power pump boasts extreme versatility

**9** • For petroleum, chemical, general-industrial or hydraulic-system use, Series *TX-10* is said to give high output combined with low cost.

Pump has 10-hp continuous input; 12½-hp for 10 hr a day. Continuous plunger load rating at normal horsepower is 1100 lb which increases to 1375 lb for intermediate service. Horizontal unit is compact, quiet-running, easily installed.

Direct drive to crankshaft by feed belts, chain drive, gear motor or variable drive is available. For top motor mounting an adjustable mounting plate covers requirements up to 10 hp. Power end features Meehanite power-frame casting, forged-steel crankshaft and connecting rod.—Union Steam Pump Company

## All-purpose industrial pump is positive-displacement type

**10** • Positive-displacement unit is inherently self-priming. It is said to maintain capacity requirements over a wide range of heads.

Pump offers suction lift up to 30 ft at speeds between 750 and 3000 rpm, with reasonably constant ca-

For more facts circle 271 on Reader Service Card, p 117 ➤

# GIANT Turbine Expansion Joints Built by BADGER

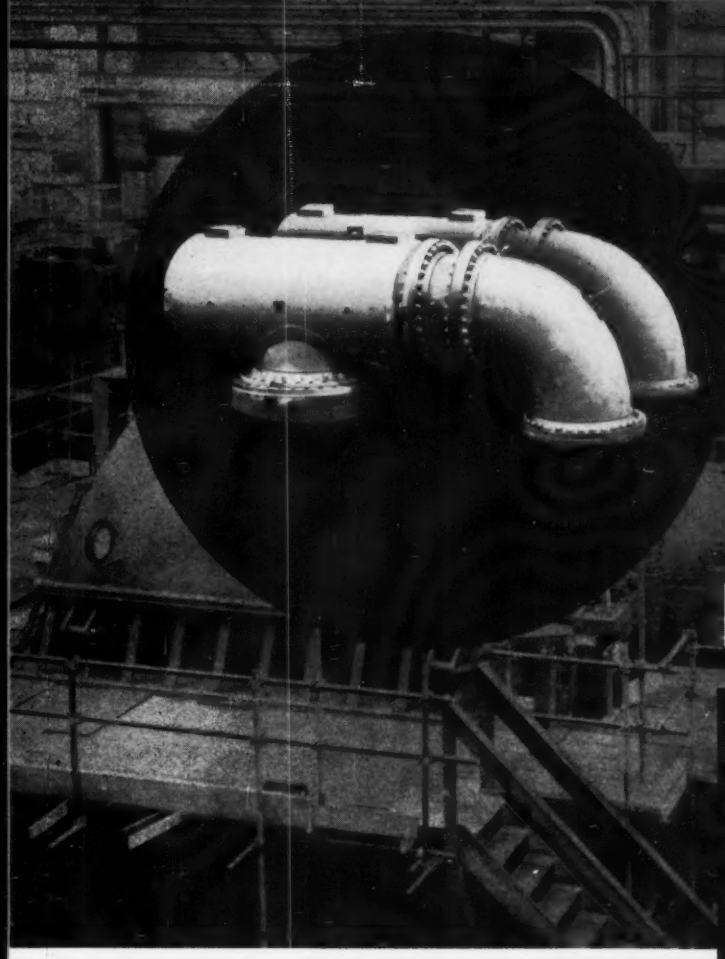
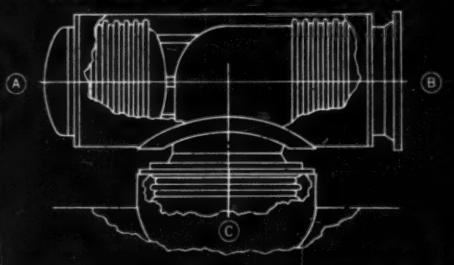


Photo shows 150,000 kw steam turbine-generator unit undergoing tests prior to shipment at General Electric's Turbine-Generator Plant in Schenectady, N. Y. Badger Expansion Assembly is clearly visible atop turbine.

Badger balanced elbow expansion assembly.




Joint A balances thrust due to internal pressure of 65-150 psi; joint B absorbs axial movement; joint C absorbs the differential expansion between the inner and outer casings of the turbine. Assemblies range in size from 36 to 42 inches in diameter.

## Custom engineered assemblies include many features of Badger S-R Design

750°F steam is flashed through these turbine crossovers at speeds up to 150 ft/sec and pressures up to 150 psi.

How do you protect piping and turbine casings from the stresses of extreme internal pressure and the expansion such temperature is bound to produce?

Working together, Badger and engineers at General Electric's Large Steam Turbine-Generator Department solved the problem with a new type pressure balanced elbow expansion assembly. Using two separate joints mounted in a T-shape casing (see diagram) the assembly effectively absorbs and controls axial movement. Although the device was custom engineered to General Electric's requirements, the bellows elements are constructed to the Curvilinear Corrugation design recently announced by Badger and now used in all S-R Expansion Joints.

Whether you need standard S-R Expansion Joints or custom equipment, Badger can serve your needs. Get more information — write for illustrated brochure today.

### *New corrugation and ring designs produce better equalization, "all-curve" flexing*

Curvilinear Corrugations used in S-R Expansion Joints were developed by the Badger Research Department. Under operating pressures (white line) the new design produces more uniform movement per corrugation and natural "all-curve" flexing. Stress is reduced... life increased.

Series 50 corrugation cross-section

S-R Joints for higher pressures have tubular Reinforcing Rings. These new rings make metal-to-metal contact only in the "valley" of each corrugation allowing natural "all-curve" flexing (white line). Tubular shape permits greater effective flexing height which contributes to longer life.

Series 150 corrugation and ring cross-section

**BADGER**

**S·R**

SERVICE RATED

**EXPANSION JOINTS**

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230 Bent St., Cambridge 41, Mass. • 60 East 42nd St., New York, New York

*Representatives in Principal Cities*

**7 big reasons why A. O. Smith *Permaglas*® glass-protected (inside and out) smokestacks are your best investment**

1. 3 to 5 times longer life than unlined steel stacks
2. corrosion resistance regardless of excess condensate
3. low maintenance — glass can't rust
4. lightweight — lower foundation cost
5. lower cost — glass protection now within reach of all
6. tough, durable — remarkable resistance to impact or abrasion
7. easy to install — no need for special equipment or highly skilled workmen

**Write Dept. P-49 for the Remarkable Facts!**

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PERMAGLAS SMOKESTACK SALES
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MILWAUKEE 1, WISCONSIN

**For more facts circle 272 on Reader Service Card, p 117**

**SAFE DEPENDABLE GENERATOR OPERATION**

*Spark Free!* **EXPLOSION RESISTANT**

*Adaptable To Any Industrial Engine!*

Kato's complete line of 50, 60 and 400 cycle revolving field AC Generators is now available in brushless design.

Especially desirable for operation in gaseous environments.

★ GREATLY REDUCED MAINTENANCE!

**KATO BRUSHLESS AC GENERATORS**

60 CYCLE SIZES
3 Phase: 5 to 400 KW
1 Phase: 5 to 150 KW

SPEEDS
720. 900. 1200. 1800 RPM.

Take your choice throughout the Kato Line — Brushless or standard slip ring types. For all your 400 cycle or power converting needs, investigate Kato's complete line of high frequency alternators and motor generator sets. Complete control systems for all Kato products include Kato magnetic amplifiers, voltage regulators, static exciters and motor starters for synchronous or induction motors.

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NEW BRUSHLESS GENERATOR CATALOG
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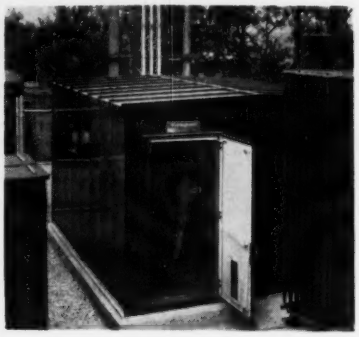
**For more facts circle 273 on Reader Service Card, p 117**


## Equipment news

*Begins on page 128*

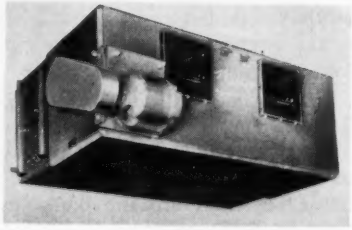
pacity maintained at any speed at pressures from 0 to 100 psi. Engaging surfaces are rubber-to-metal, for good service in handling corrosive and abrasive liquids or liquids with solids in suspension. Rubber is bonded to metal inserts to give extra strength and resilience. Only lubricating medium is the liquid being pumped.—Goodyear Pumps Inc



### Switchgear shelter area

**11** • Built as an integral part of the outdoor metalclad switchgear structure, service work area is made by extending end enclosure of the housing. Standard 3-ft sections make up a 9-ft addition giving space for station control batteries, tools, storage. Location of control batteries near breakers eliminates conduit runs, reduces voltage drops associated with long leads. —Westinghouse Electric Corporation

Just circle key numbers on the reader service card, page 117, to get complete product story



### Air-cooled condenser

**12** • Blower type air-flow air-cooled unit has low silhouette, making roof installations rarely visible from the ground. Condenser requires minimum space for indoor ceiling suspension.

When equipped with optional accessories, unit will condense refrigerant, as well as heat and ventilate. Seven models have nominal capacities from 10 to 50 tons.—McQuay, Inc

**continued**

Neither stargazer nor mystic, this K & M technician can nevertheless see into the future. His crystal ball is a small mass of radioactive Iridium; his fortune-telling cards, gamma-ray pictures of critical valve assemblies. With these pictures he searches out the kind of subtle flaws and tiny imperfections that could become trouble spots at some future time. And so he is able to predict and prevent in-service failures and malfunctions.

Radiographic inspection is just one way in which K & M works to insure a long and healthy service life for its products. K & M's in-plant quality control facilities range from a contour comparator, for precision checking of small parts, to a 4000-gpm flow test loop, where sample valves from the production line are tested for on-stream performance. Micrometer and calipers play an important part, too, for each K & M valve is subjected to more than eight hundred dimension check-outs before it reaches the shipping crate. It's either perfect, or "no go."

K & M's meticulous standards of quality control are neither myth nor magic . . . just good business — for us, and for you.

For a more detailed view of our plant and production practices, send for the well-illustrated, informative brochure, "This Is K & M."

K&M

diaphragm control valves

Our 79th Year

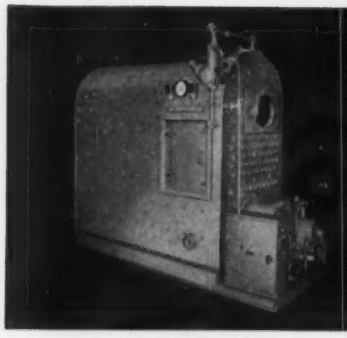
KIELEY & MUELLER, INCORPORATED

*Oldest Pressure and Level Control Valve Manufacturer*
64 Genung Street, Middletown, New York

S.A. 1902



For more facts circle 274 on Reader Service Card, p 117



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2. **LOWER OPERATING COST** — Guaranteed 81% efficiency means greater fuel economy—and water tube design assures the fastest generation of steam or hot water.

3. **LOWER MAINTENANCE COST**—Water cooled tube ends plus full access to both the fireside and waterside of all tubes reduces maintenance time and cost to an absolute minimum.

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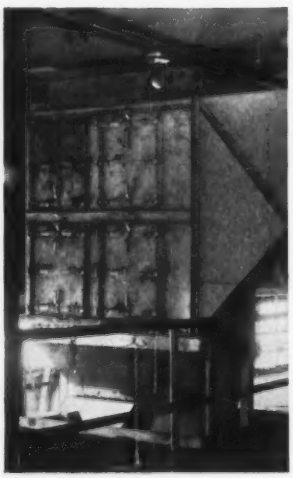
For more facts circle 275 on Reader Service Card, p 117



NIAGARA MOHAWK POWER CORP.* prevents GAS AND COAL DUST ACCUMULATION with



## DUSTEX COLLECTORS

Engineers of Niagara Mohawk Power Corp., Buffalo, N.Y., prevented an accumulation of explosive gas and dust at its Huntley Steam-Electric Station — with two Dustex Miniature Cyclone Collectors ventilating bunkers and hooded belt transfer points. Results — gas removed — fines salvaged and returned to bunker continuously. No visible discharge from stacks! Maintenance — none to date, thanks to Dustex high-efficiency, non-plugging design which employs no filters, and Dustex Vacuum Valves which have no moving parts.

*SEE FOR YOURSELF* the efficient performance of Dustex on your job, at no obligation. Write today for Dustex Bulletin "A Simplified Determination Test."

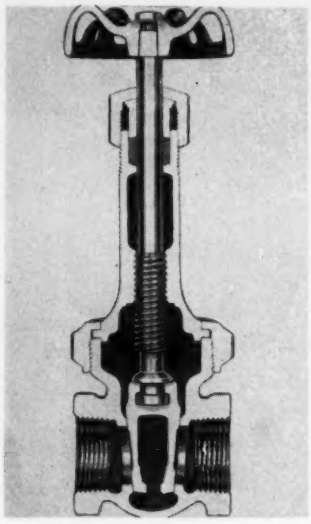
*Contractors: STONE AND WEBSTER ENGINEERING CORP.

Dustex CORP.

P. O. BOX 2520 • BUFFALO 25, N. Y.


## Equipment news

Begins on page 128

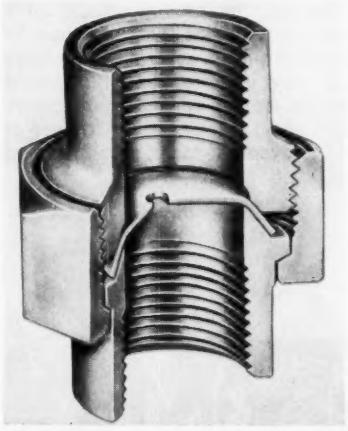


### Union-bonnet gate valve

**13** • Bronze units feature union bonnets which permit frequent dismantling and reassembly for inspection and service. Design also provides strength at bonnet joint: when union ring is pulled down, body and bonnet mating surfaces come together for a tight seal that won't loosen in ordinary operation.

Rising-stem valves are made in sizes from ¼ to 3 in.—Ohio Brass Company

Just circle key numbers on the reader service card, page 117, to get complete product story



### Gasketless orifice unions

**14** • Unit features a cup-shaped stainless-steel orifice plate. Plate fits between conventional pipe-union head and tail pieces to form a tight, leak-



For more facts circle 276 on Reader Service Card, p 117

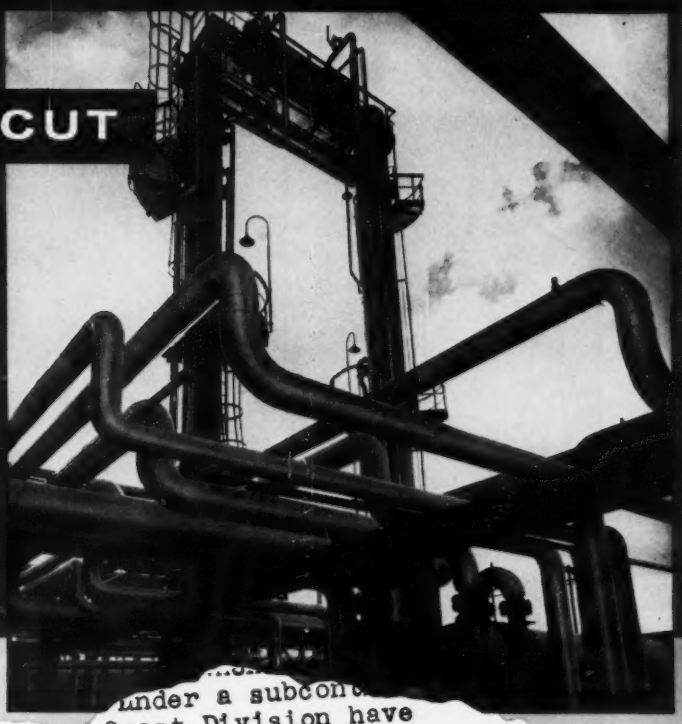
circle 277 on Reader Service Card, p 117 ➤

# NOT ONE FIELD CUT

## in all This

# MIDWEST

## Shop-Fabricated Piping



...Under a subcon...
and I would like to say the West Coast Division have on this job complied fully with the high standards of workmanship for which Midwest is known.

Throughout this entire project not once was a cut necessary to correct any piece of fabrication, and I might add in several instances close tolerances had to be met.

The above was not written on an impulse but as construction superintendent, this means but one thing: fast and low cost erection. Would appreciate your thanking Midwest personally for my [illegible]om a construction

**Excerpt from letter by:**
**HOLMES & NARVER • Engineers-Constructors**
**828 South Figueroa St. • Los Angeles 17**

Note particularly the words "*fast and low cost erection*" in the above letter. They characterize Midwest Shop-Fabricated Piping . . . whether for refinery, power plant or industrial installations. In this instance they were written by A. H. Chamberlain, construction superintendent, upon completing the installation of a Houdriformer Unit at the U.S. Oil & Refining Co., Tacoma, Washington.

There are three well-equipped Midwest pipe fabricating shops located to serve economically all sections of the country. Each is staffed by a highly skilled organization using the latest techniques. Each has wide experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. You too will find it to your advantage to call in Midwest whenever you need fabricated piping.

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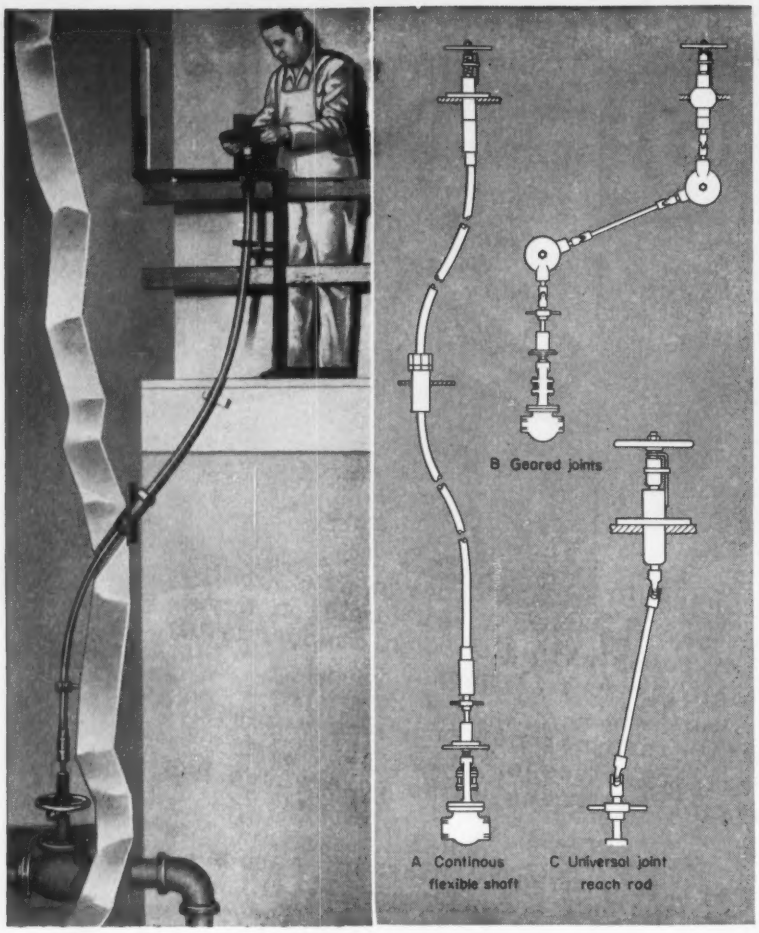



## Typical station arrangements

# Remote control for valves

In recent years increasing numbers of manual remote controls have been installed in industrial power plants and on nuclear reactors. These systems are popular because they eliminate a great deal of hazardous climbing and permit relatively inexpensive control of a number of widely scattered valves.

Stow Manufacturing Co. makes a complete line of these controls, including: flexible shafting, universal joints and geared joints. These controls also include standard remote stations, intermediate connections and valve couplings for both flexible shafting and reach rods.

Typical installations of this equipment are shown above. Sketch "A" shows a flexible shaft that can be used up to 100 ft. in length and is available in sizes up to 1⅜" diameter. Sketch "B" is an installation using geared joints that operate in any angle through 340°.

For complete design data on all sizes of standard flexible shafts, geared joints and terminals, write for Design Manual 5811.

**STOW MANUFACTURING CO.**
**181 Shear Street, Binghamton, N. Y.**

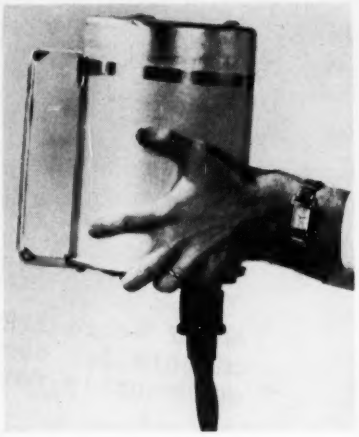

## Equipment news

Begins on page 128

proof seal. Separate gaskets are eliminated, according to manufacturer.

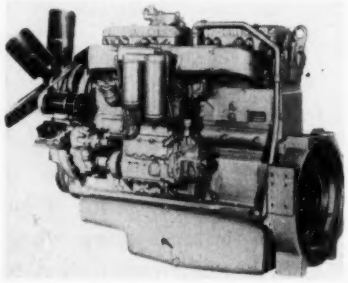
Units are made in ⅛- to 2-in. pipe sizes, with a 3000-psi pressure rating. —Catawissa Valve & Fitting Co

Just circle key numbers on the reader service card, page 117, to get complete product story



### Mercury ballasts

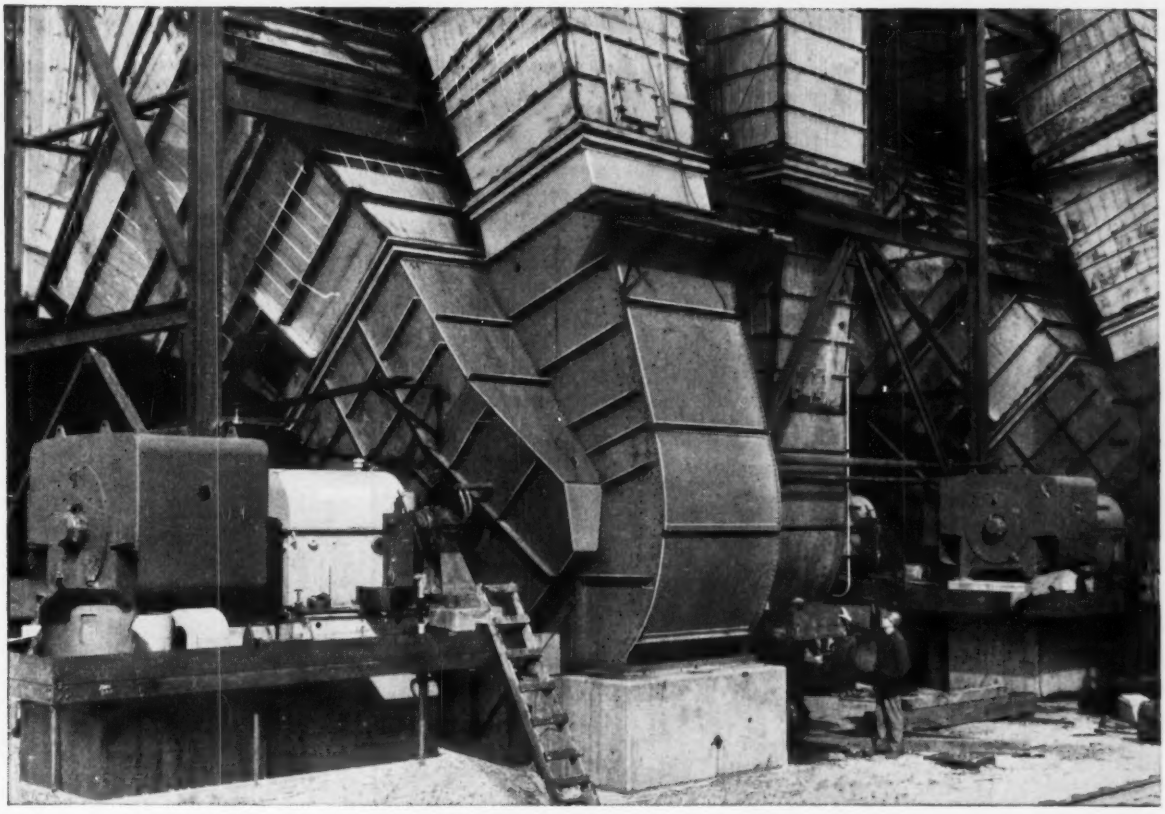
**15** • Designed for use with mercury lamps from 100 to 425 watts, ballasts come in regulator and reactor styles. Smaller, lighter design is said to give higher efficiency and improved regulation. — General Electric Company, Outdoor Lighting Dept



### Heavy-duty diesel engines

**16** • Two new engines feature 2-stage controlled-turbulence combustion. Initial "swirl" turbulence is produced on intake stroke; second-stage turbulence or "squish" builds up as pistons near top of compression stroke. Swirl and squish add up to easy starting, fast acceleration, a clear exhaust and low fuel consumption, according to the manufacturer.

One model, the *21000*, is turbocharged and develops 340 hp at 2000



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The "Buffalo" Family of "BLH" Fans is designed for highest mechanical efficiency over an extremely broad operating range. Peak efficiencies are up to 86%. Rugged "Buffalo" construction insures economical, dependable operation throughout a long, trouble-free life.

"Buffalo" Type "BLH" features include: streamlined housing designed to deliver ultra-smooth air flow, peak static conversion and pressure distribution at outlet — turbulence minimized by smooth inlet bell, directional inlet vanes, backward-curved blades, matching rotor flange and inlet bell and gradually divergent outlet. These features all add up to the quiet, powerful, smooth performance characteristic of the "BLH".

Reliable, maintenance-free operation is the result of extra-heavy construction throughout. This includes sturdy steel plate construction ruggedly welded for extra strength — oversized shafts and bearings. Rotors are statically and dynamically machine balanced at factory.

If your mechanical draft conditions require a dependable fan that provides high efficiency over a broad operating range, ask your "Buffalo" engineering representative for complete facts about the "Buffalo" family of mechanical draft fans. Or you can write us direct for Bulletin FD-905.

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VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING



For more facts circle 279 on Reader Service Card, p 117

**There's no waste water from a V-notch**

Why?

Because a V-notch Chlorinator needs no auxiliary water supply.

You can plan on clean, dry chlorinator rooms with no messy drain—no chlorine gassing back. And best of all... gone forever is the high cost of wasted auxiliary water.

And, of course, the right plastics make the whole chlorinator chlorine-proof.

Yet these are just added benefits to the main job: Simple, dependable, wide range chlorine control. The kind of control you get only with a W&T V-notch Chlorinator.

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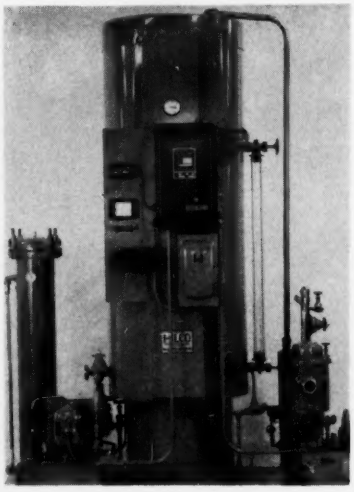
## Equipment news

*Begins on page 128*

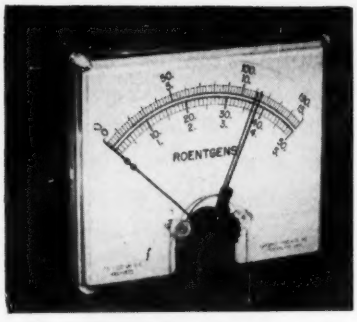
rpm. The *16000*, p 136, is naturally aspirated, develops 230 hp at 2000 rpm. Both are 6-cylinder, 4-cycle, in-line engines.—Allis Chalmers Manufacturing Company



### Insulating-oil reclaimer

**17** • Unit purifies sealed-transformer insulating oil before it is delivered to transformer charging boards. System is compact, taking up only a 3x6 ft space. It is composed of an inlet filter using fuller's-earth filter cartridges; submerged inlet and outlet rotary-gear pumps, each driven by its own motor; an electrically heated vacuum vaporizer with built-in 60-gal vacuum storage tank; a vacuum pump.—Hilliard Corporation

Just circle key numbers on the reader service card, page 117, to get complete product story




### Minified control

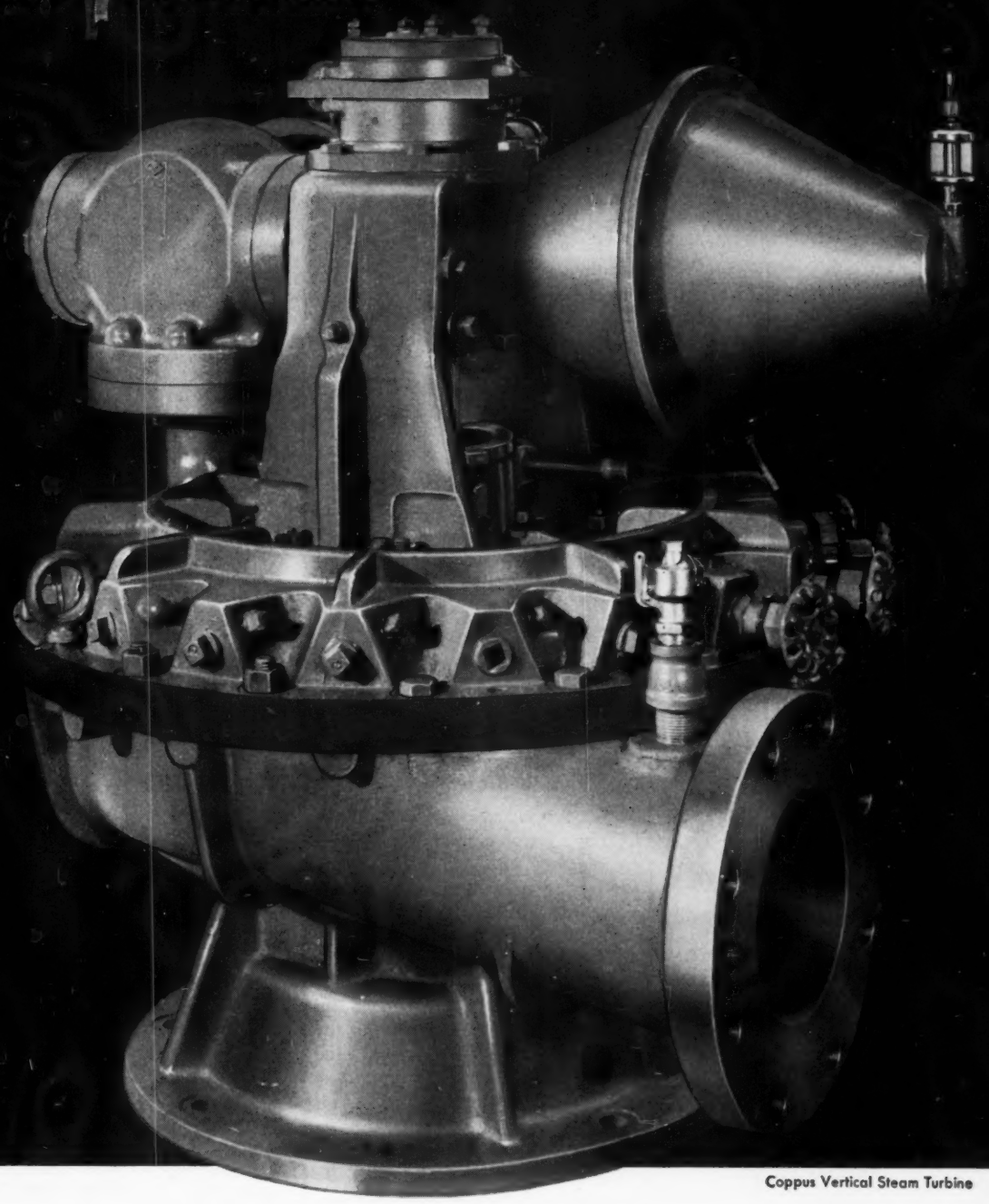
**18** • Said to be smallest self-contained instrument ever built in production quantities around locking-contact meter-relays, this instrument



For more facts circle 280 on Reader Service Card, p 117

circle 281 on Reader Service Card, p 117 ➤

COPPUS BLUE RIBBON PRODUCTS



Coppus Vertical Steam Turbine

***THE MARK OF QUALITY*** — There's no better test of a turbine's quality than performance. And the new, ruggedly designed, power-packed Coppus Turbines pass all performance tests with top honors! Small wonder. Coppus quality is literally designed and built into them. Their super stamina is the end-product of painstaking craftsmanship, finest materials and methods, thorough testing and control. Each truly deserves its Blue Ribbon . . . assurance of *complete* reliability.

Typical Coppus Blue Ribbon features are: *totally enclosed governor . . . totally enclosed and independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.* You get higher efficiency operation . . . less down time . . . lower maintenance costs.

Coppus Turbines are built to customers' specifications, including API and NEMA standards. Send for Catalog 200. Get complete details on Coppus Turbines. Sizes from 1 HP to 250 HP. Write COPPUS ENGINEERING CORPORATION, 164 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

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go YARWAY with confidence


## Equipment news

Begins on page 128

occupies no more panel space than a standard 4½-in. indicating meter. It mounts just as simply. All control components are housed in a round barrel 2⅞-in. dia and 4¾-in. deep.

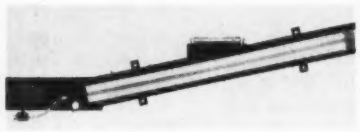
Unit provides continual signal indication. When preset limits are reached, it triggers control action. High or low signal limits may be set by adjusting fixed pointers.—Assembly Products, Inc

### Electroluminescent lamps

**19** • New indicator device produces light by electroluminescence: flat panels of glass with an electrical conductive film are coated with a special phosphor. When electricity is applied, the panel glows.

Readout lamps should find use in computers, status boards and indicator panels. Letters are formed by energizing specific segments of the 14-segment alpha type lamps or the 10-segment numeric type lamps. Numerals are distinct and easily readable even at wide-angle viewing; require a minimum of space.—Westinghouse Electric Corporation

Just circle key numbers on the reader service card, page 117, to get complete product story



### Inclined-tube manometers

**20** • General-purpose inclined-tube units are highly sensitive, measure pressure, vacuum, differential pressure or flow in industrial applications where cost of a laboratory in-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These tested methods will help you help yourself to a bigger-paying job—pay big dividends in increased production and power output, reduced time for maintenance and repair. All operating principles are explained simply with a minimum of complicated theory. And, in addition to covering machines and basic equipment, the Library also explains the various control devices and accessory equipment found in the modern plant.

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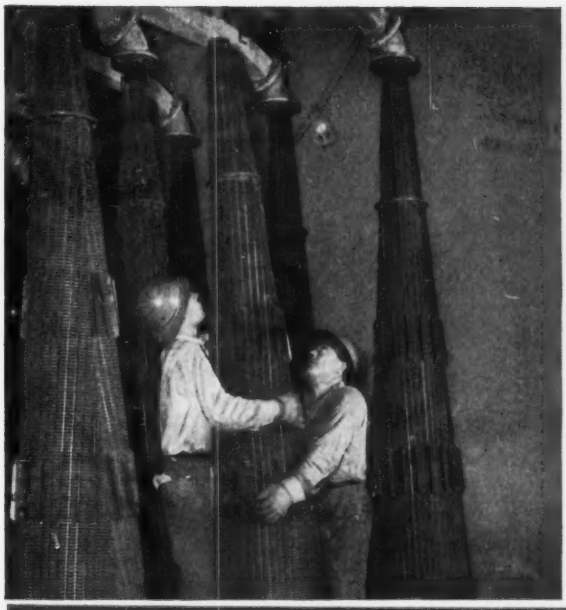
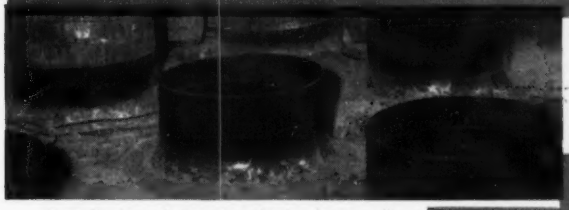


# 72 tons of *FLY ASH* collected a day!

## GREEN'S AERODYNE HELPS SOLVE CONSOLIDATED EDISON'S FLY ASH PROBLEM



*Installation of Aerodyne Units at Consolidated Edison's Hell Gate Electric Generating Station.*

Green makes this AERODYNE mechanical dust collector, to collect fly ash and other dusts. Does this Green AERODYNE really work?

Well, let's quote a few words from Mr. J. J. Grob, Chief Performance Engineer, Mechanical Engineering Department, Consolidated Edison Company of New York, Inc.

**QUOTE 1**
***Why used*** ..... "At Hell Gate Station two Aerodyne mechanical collectors were installed in the uptake flues of boilers No. 11 and 12 for removing the bulk of fly ash leaving the furnaces."

**QUOTE 2**
***72 tons of fly ash per day*** ..... "The furnaces are slag tap and, of that ash which would otherwise be expelled to the electrostatic precipitators before entering the stack, the Aerodyne units, based on careful tests, remove approximately 72 tons of fly ash per day."

**QUOTE 3**
***Satisfactory*** ..... "The operation of the Aerodyne mechanical collectors has been satisfactory and the life of the cones has greatly exceeded expectations."

We repeat, in all modesty — Green can help you solve FLY ASH and DUST collection problems.

Why not write and ask us?

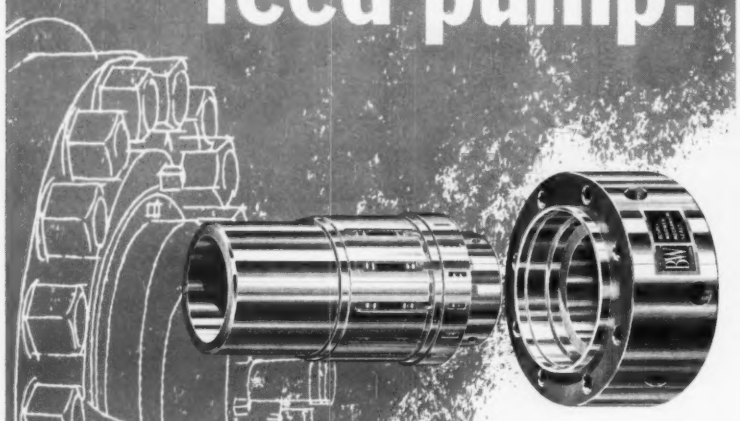
**Green**

**THE GREEN FUEL ECONOMIZER CO., INC.** **BEACON 3, NEW YORK**



For more facts circle 284 on Reader Service Card, p 117

# cut kw costs on any boiler feed pump!



## Borg-Warner Mechanical Seals

Shaft leakage on a boiler feed pump means more than a little lost water. You can actually measure—in BTU's—the heat lost in expensive treated feed water.

"Type D" Borg-Warner Mechanical Seals are designed for the high temperatures and pressures of boiler feed service and cut this leakage to an absolute minimum. At the same time, they eliminate costly maintenance and down-time required with packing or inadequate sealing methods.

The end result is lower pump operating costs, and *lower cost per KW!*

**NOW AVAILABLE**—*a new 12 page bulletin describing the Borg-Warner Type "D" Seals. Operation, construction, installation and other useful information is included—write for your copy today!*

A PRODUCT OF B-W BORG-WARNER®

**Borg-Warner® Mechanical Seals**

P.O. Box 2017, Terminal Annex, Los Angeles 54, Calif.


## Equipment news

*Begins on page 128*

strument is not thought to be justified.

Inclined indicating tube means that liquid moves a greater distance for a given pressure change—scale divisions are farther apart, instrument is more sensitive, easier to read.

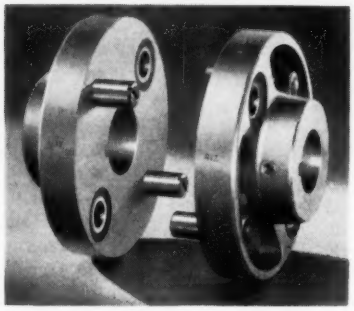
Units are available with scale lengths of 20 to 60 in., vertical ranges of 2 to 20 in. in most sizes. Maximum working pressure is 350 psig.—King Engineering Corp

**Just circle key numbers on the reader-service card, page 117, to get complete product story**

### Cellular glass insulation

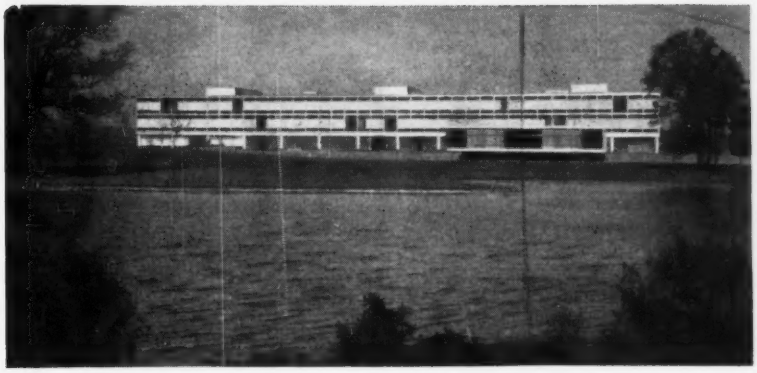
**21** • Low-cost rigid insulation is designed for hot and cold commercial piping applications. Made of special *Foamglas*, insulation is offered in a temperature range of 35 to 350 F.

Material is shipped in 24-in. lengths, factory-wrapped with dual-purpose kraft and aluminum-foil laminate. Covering is available in nominal thicknesses of 1 and 1½ in. for steel pipe or copper tubing from ½ to 6 in. dia. —Pittsburgh Corning Corporation



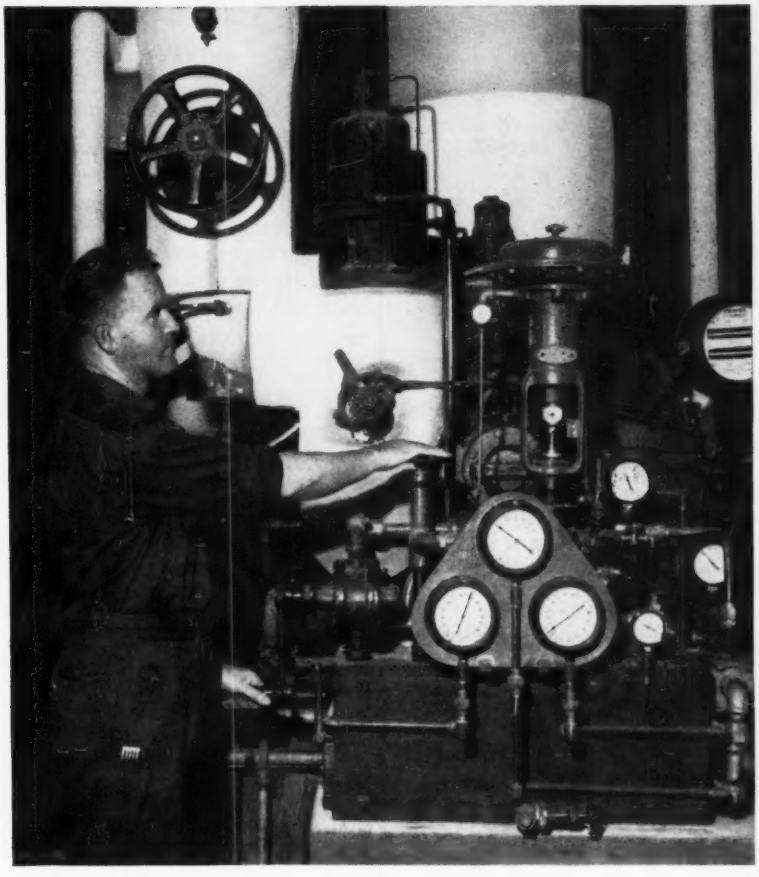
### Flexible couplings

**22** • *Series 400* couplings are designed for use on direct-driven machinery where torque is not excessive in relation to shaft diameter. Four studs and sleeve bearings provide



New home office for Connecticut General Life is a modern structure five miles out in the country.

# Terry turbines power air-conditioning system at new Connecticut General Life building



One of two 870-hp, 3970-rpm Terry turbines built to drive the refrigeration compressors.

The new home office of the Connecticut General Life Insurance Co., in suburban Hartford, represents the best in contemporary architecture as well as construction techniques and materials.

In keeping with the careful planning evident throughout the project, two Terry turbines were selected to drive the York centrifugal refrigeration compressors. Terry turbines such as these have a record of low maintenance and consistent reliability under varied conditions. The steam generators, which are used for general heating during the winter months, furnish the power to operate the turbines. This provides an economical and dependable air-conditioning setup.

The steel and glass building accommodating 2500 employees overlooks New England farmland. It is furnished with modern equipment, to step up the efficiency of clerical work. Other amenities: lounges, game rooms, cafeteria, bowling alleys, barber and beauty shops, variety store, medical department.

If you are planning an air-conditioning system, perhaps you, too, should consider steam-turbine drive. Write for detailed information about the advantages of turbines for your specific requirements.

**THE TERRY STEAM TURBINE CO.**
**TERRY SQUARE, HARTFORD 1, CONN.**

TERRY

TT-1213



For more facts circle 286 on Reader Service Card, p 117

# Quiet, Efficient, Convenient

**Ideal for Hospitals, Hotels, Apartments, and Industries where noise is objectionable.**

Rotojet Electric Tube Cleaner thoroughly cleans straight tubes from 25/32" to 4" I.D. in boilers, condensers, evaporators, and heat exchangers so quietly that it can be operated without disturbing anyone.

This self-contained unit comprises a powerful motor, rotatably mounted on a stand, a required length of heavy duty flexible shaft, a 20 ft. cable, and a selection of heads, brushes, drills, and scrapers to meet any cleaning need. The motor swivels and rotates so that tubes on top, bottom, and sides can be cleaned without moving the unit. A few of the many types of heads available are shown below.

Bulletin 107 gives full details of this quiet, efficient, convenient tube cleaner. Send for it now.

*Rotojet Electric Tube Cleaner with swing-frame head.*

*4-way drill and universal coupling.*

*Expanding wire brush.*

ELLIOTT COMPANY – ROTO PLANT
*Tube Cleaner Specialists Since 1910*
153 Sussex Avenue, Newark, N. J.


## Equipment news

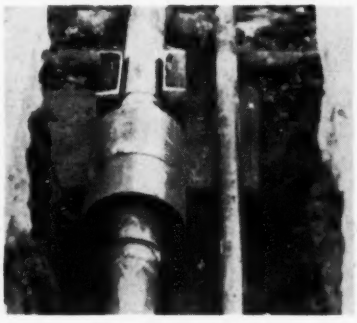
*Begins on page 128*

positive, resilient drive. No lube is needed. Cast semi-steel flanges are accurately machined on periphery and face. Couplings come in four sizes, with 1¼-, 1¾,- 2¼- and 2¾-in. maximum bore.—Ajax Flexible Coupling Co, Inc

### High-head centrifugal pumps

**23** • Self-priming units come in 1½ through 6-in. sizes and are available with base mounting, pneumatic tires or steel wheels. They may be belt-, flexible-coupling- or direct-connected engine driven.—Rice Pump & Machine Company

Just circle key numbers on the reader service card, page 117, to get complete product story



### Expansion joint

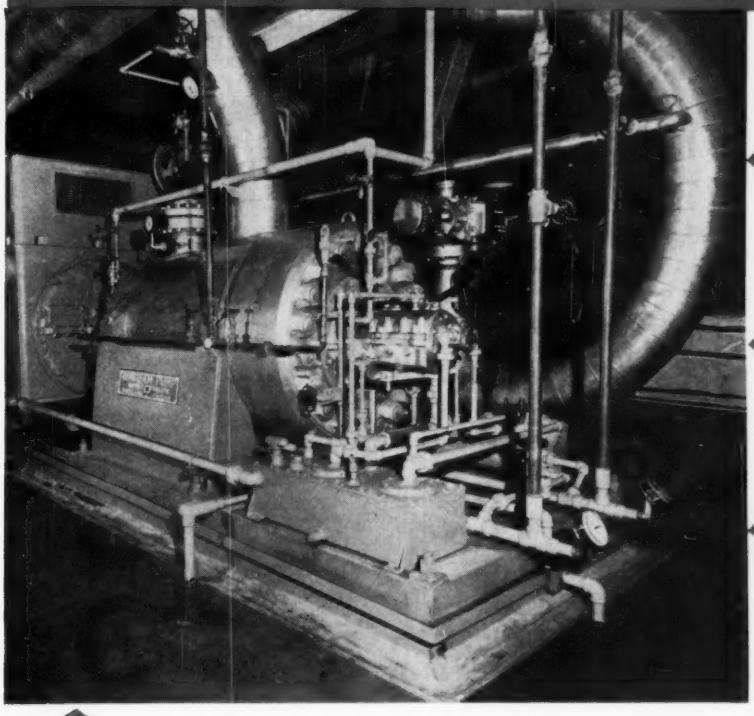
**24** • Steam-line construction method eliminates need for concrete conduit and manholes in most installations. Newly designed expansion joint can be covered to protect the bellows from loose insulating material. Joints are fabricated from weldable wrought steel, without bulky castings to interfere with installation of heavy-duty covers needed for protection.

In new system, trench is dug, pipe

# Bingham

## "DOUBLE VOLUTE" BARREL TYPE BOILER FEED PUMPS

## THE ULTIMATE IN DEPENDABILITY FOR HIGH PRESSURE SERVICE



BINGHAM BARREL TYPE HIGH PRESSURE BOILER FEED PUMPS

PACIFIC POWER AND LIGHT COMPANY
Glenrock, Wyoming

ENGINEERS AND BUILDERS
Ebasco Services, Inc.

*Bingham* Barrel Type Boiler Feed Pumps, installed in the Pacific Power & Light Company plant at Glenrock, Wyoming. Each pump is designed to deliver 1875 GPM at 2300 PSI, operating at 3560 RPM.

*Bingham* "Double Volute" Barrel Type Boiler Feed Pumps are furnished with forged outer barrel for high pressure service. Pumps of this type are available for a wide range of capacities and heads. Your nearest *Bingham* office will be glad to give you full details on request.

**BINGHAM BARREL TYPE BOILER FEED PUMPS feature:**

- "Double Volute" construction.
- Double suction first stage for low NPSH.
- Balanced axial thrust (no balancing drums needed).
- Kingsbury Thrust Bearings.
- Stuffingboxes are arranged for either packing or mechanical seals.
- Stuffingboxes are subjected to suction pressure only.
- Designed for high operating speeds.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

**BINGHAM PUMP COMPANY**
*General Offices:* 2800 N. W. Front Avenue, Portland 10, Oregon
*Factories:* Portland, Ore. • Vancouver, B. C., Canada

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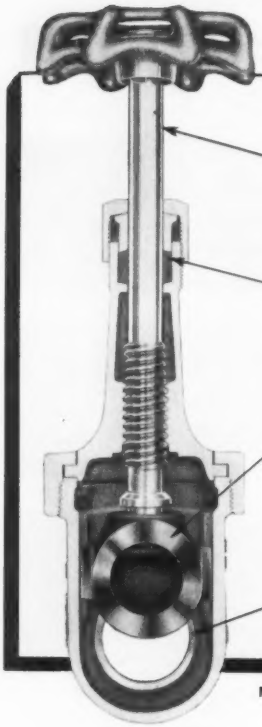
Outstanding Valve performance with

# KENNEDIZED DISCS

an entirely new development in bronze gate valve construction that extends service life beyond comparison . . .



**PROVEN BY USE!**

***KENALLOY STEM . . .***

Exclusive KENNEDY alloy that prevents dezincification and corrosion and provides smooth, non-galling threads and bearing surfaces. In a rugged use test, this stem withstood a mechanical loading of 18 foot-pounds closing torque and after 25,000 cycles was like new!

***PACKING . . .***

New type packing made of molded graphite asbestos with a Buna "N" binder required no replacement during or after 25,000 cycles.

***KENNEDIZED DISC . . .***

In punishing use tests, the super mirror finish of the KENNEDIZED disc actually improved with wear! Disc showed no galling or other wear marks after 25,000 cycles at 150 lbs. saturated steam pressure. This remarkable wear resistance is combined with an extremely low coefficient of friction, smooth sliding properties, excellent anti-seizure characteristics and corrosion and galling resistance. Tests and in-use results prove these discs set a new and unmatched high standard in valve performance.

***SEAT . . .***

Due to the low coefficient of friction and smooth sliding properties, the action of the KENNEDIZED disc actually improved the finish on the seat. Here, again, no galling was found on the seat after 25,000 cycles.

For the complete KENNEDIZED DISC story, write for Bulletin 574.

Fig. 525KD
125-Pound S.W.P.
Bronze Gate Valve.

## KENNEDIZED DISCS
## NOW AVAILABLE IN THESE KENNEDY VALVES . . .

**FIG. 427KD**
**125-Pound S.W.P. Bronze Gate Valve**—Non-Rising Stem, Inside Screw, KENNEDIZED Wedge Disc.
WORKING PRESSURES: Saturated Steam, 125 lbs.; W.O.G., Non-Shock, 200 lbs.

**Fig. 525KD**
**125-Pound S.W.P. Bronze Gate Valve**—Union Bonnet, Rising Stem, Inside Screw; KENNEDIZED Wedge Disc.
WORKING PRESSURES: Saturated Steam, 125 lbs., W.O.G., Non-Shock, 200 lbs.

**Fig. 78KD**
**200-Pound S.W.P. 550° F. Bronze Gate Valve**—Union Bonnet: ¼"-2"; Bolted Bonnet: 2½"-3"; Rising Stem, Inside Screw; KENNEDIZED Wedge Disc.
WORKING PRESSURES: Steam at 550° F., 200 lbs.; W.O.G., Non-Shock, 400 lbs.

**Fig. 518KD**
**300-Pound S.W.P. 550° F. Bronze Gate Valve**—Union Bonnet: ¼"-2"; Bolted Bonnet: 2½"-3"; Rising Stem, Inside Screw; KENNEDIZED Wedge Disc.
WORKING PRESSURES: Steam at 550° F., 300 lbs.; W.O.G., Non-Shock, 600 lbs.

**KENNEDY VALVE MFG. CO.**
ELMIRA, NEW YORK

• OFFICE AND WAREHOUSES IN PRINCIPAL CITIES

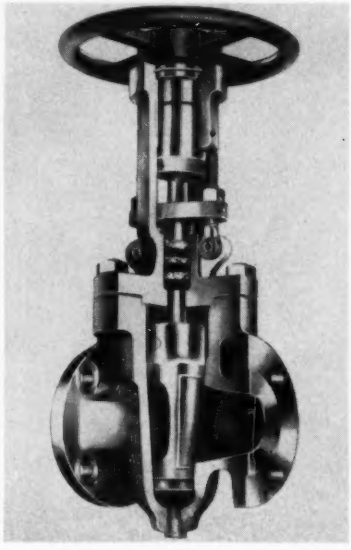
DUCTILE IRON VALVES • CAST IRON VALVES • BRONZE VALVES • INDICATOR POSTS • FIRE HYDRANTS


## Equipment news

Begins on page 128

laid, anchors and guides installed, line packed with granular poured-in-place hydrocarbon insulation and covered. As line is heated, insulation cures to a 3-layer covering: plastic in contact with line, sintered in the middle, loosely granular on the outside. —Badger Manufacturing Company

Just circle key numbers on the reader-service card, page 117, to get complete product story



### General-purpose valve

**25** • Two Teflon O-rings are used in this nonlubricated valve. Unit will double-block and bleed in most services to do the job of two ordinary valves, according to the maker.

Unit needs no maintenance. Pressure-sealing effect of the O-rings provides absolute shutoff, permanently bubbletight. — Stockham Valves & Fittings

### Tramp-iron separator

**26** • Permanent ceramic magnets made of barium ferrite are feature of new line of separators. The ceramic material is compacted under great pressure, then permanently magnetized to produce a good flux pattern for maximum effect.

The permanent magnets are installed in magnetic pulleys, for use at the head of a belt-conveyor system, or in grate magnets for use in a hopper, chute or duct.—Stearns Magnetic Products

In Bulletin No. 6050 on P-K forced boiler water heat exchangers complete capacity tables are provided, grouped by temperature ranges. Pressure drop is shown for each capacity. Dimensional data supplied

Catalog No 19 covers P-K storage water heaters in plain steel, copper-lined, copper silicon, Pre-Krete lined, clad and galvanized. In addition to tabular data on capacities, weight and dimensions, this book carries a handy conversion table to determine capacities of heating sections with various temperature ranges and steam pressures

Catalog No. 202 describes P-K instantaneous water heaters. Contains capacity tables covering two, four and six pass design. Tables are grouped by steam pressures ranging from 0 to 100 psi. Inlet and outlet temperatures are listed with hot water capacities.

In this P-K Bulletin No. 303-A, covering convertors for forced circulation water heating systems, capacity tables include the usual ranges for standard water heating systems. Also included are general ranges for radiant heating systems.

# FOUR P-K CATALOGS YOU NEED

*when specifying any hot water system...*

## AND HOW TO GET YOUR COPIES

With these four P-K catalogs on your desk you have installation and performance data, conveniently tabulated on instantaneous hot water heaters, storage water heaters, convertors for water heating systems and forced boiler water heat exchangers. Just write us for P-K heating equipment file #126 and we'll send you the set. The Patterson-Kelley Co., Inc., 2504 Warren Street, East Stroudsburg, Pa.

6

**Patterson Kelley**

Water Heater Division

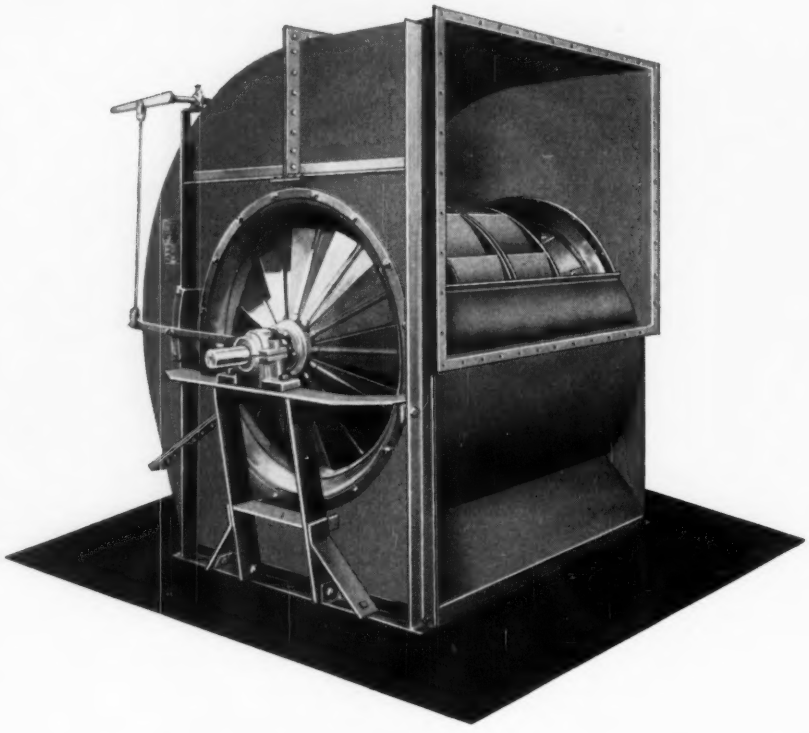
storage water heaters • instantaneous heaters • convertors • water to water exchangers



For more facts circle 290 on Reader Service Card, p 117

# CLARAGE

*Presenting new highs in quietness and dependable broad efficiency...*



## NEW DYNAFOIL heavy-duty FAN

### featuring a perfected airfoil blade design

With this new Clarage Type AF Dynafoil Fan you get stable high efficiency where it counts—under actual operating conditions.

Ideally suited to mechanical draft and heavy-duty applications, such as industrial processes, conduit type air conditioning, and tunnel ventilation, this latest in the Clarage line of superior fan equipment is built in 13 sizes, Classes II, III, and IV construction.

WRITE FOR CATALOG 859 which provides outlined dimensions and description of new Clarage Type AF Dynafoil Fans. Or contact nearest office.

*Dependable equipment for making air your servant*

**CLARAGE FAN COMPANY**

*Kalamazoo, Michigan*

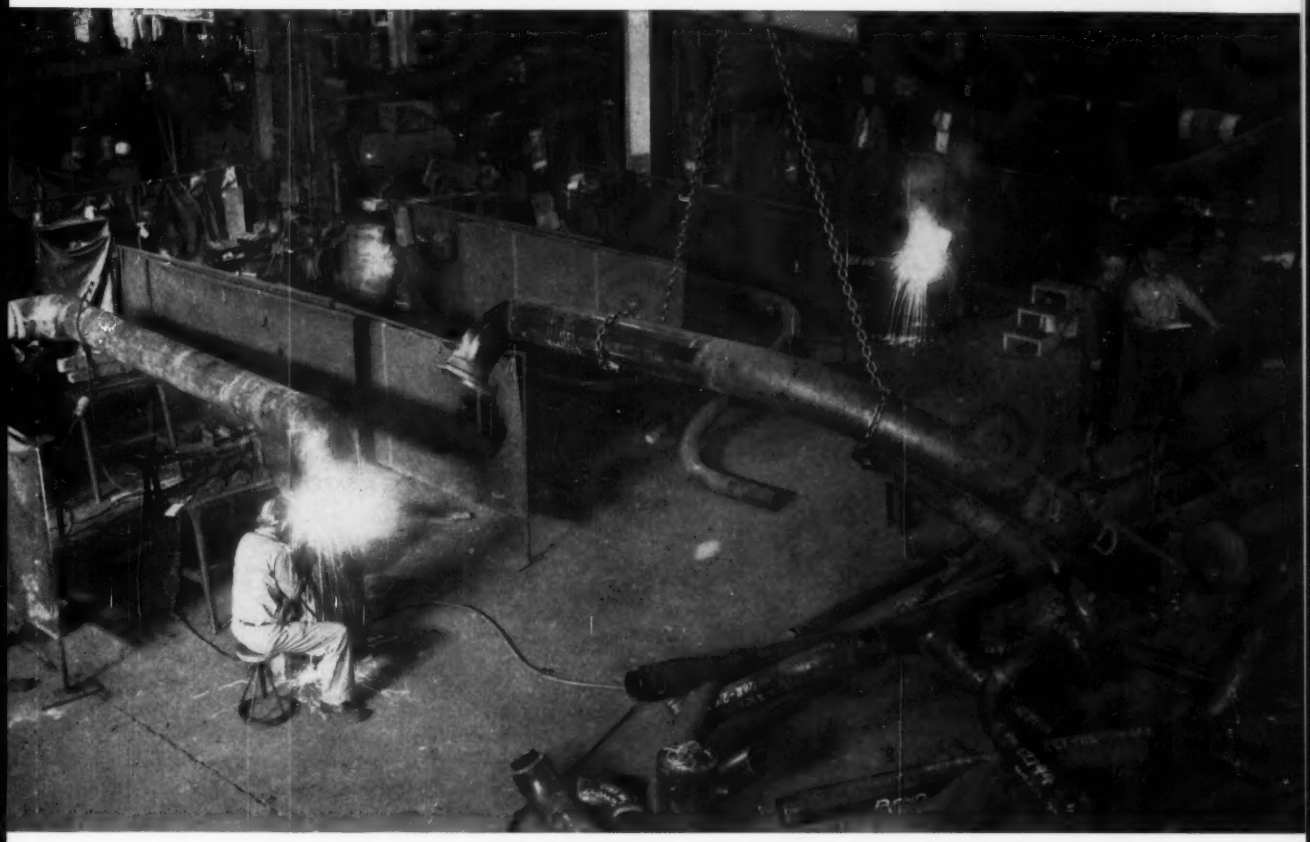
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



For more facts circle 291 on Reader Service Card, p 117

For more facts circle 292 on Reader Service Card, p 117 ➤

# How Blaw-Knox cuts your power piping costs



**121,000 square feet of space at your service.** Power piping facilities at Pittsburgh include 56,000 square feet of plant area and an additional 65,000 square feet for exterior storage. An additional new plant is located on a 15-acre site in Jackson, Mississippi.

Your job is under the personal supervision of an experienced engineer, who follows your project from beginning to end. Your piping is handled with the most modern equipment for welding, heat treating, and bending. Fabricating techniques, proven by rigid testing, are used.

**New product development.** Blaw-Knox developed an enclosed type of functional spring hanger as part of their complete line of hangers for supporting any piping system. Here a group of hangers individually designed for a project is factory checked to assure fast field erection.

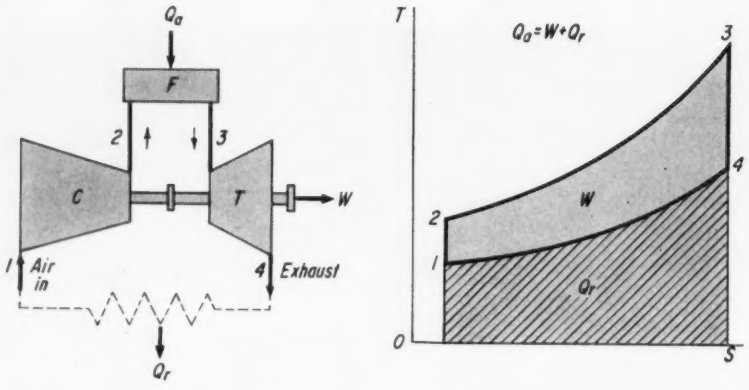
**Stress calculation cut from months to a day . . .** with pace-setting engineering. An exclusive Blaw-Knox method uses an electronic computer for automatic computation with no limitation on the complexity of system. Full accuracy, with tremendous savings in time and cost. Write for details.

BLAW-KNOX

**BLAW-KNOX COMPANY**

*Power Piping Division*

*829 Beaver Avenue, Pittsburgh 33, Pennsylvania*




**Steady-flow internal-combustion engines have proved their practicality in the last ten years. Now let's learn . . .**

1 Simple open-cycle gas-turbine unit, *left*, has three major elements: *C*—compressor, *F*—combustor, *T*—turbine. Compressed air heated in combustor drives turbine

By B G A SKROTZKI, Associate Editor

# How to analyze gas-turbine engines

Now that we know the basic thermo of steady-flow working fluids we are ready to study the well-known gas-turbine engine, Fig. 1. The simple open-cycle engine has three main parts: (1) rotary compressor *C* (2) combustor or furnace *F* and (3) gas turbine *T*. The unit gets its name from the turbine which takes its energy input from hot pressurized gas flowing through it.

Compressor *C* draws air in steady flow from the atmosphere and pressurizes it adiabatically. The air then flows into the furnace. Fuel injected into the air flowing through the furnace burns to raise the temperature of both the air and combustion gases, at constant pressure.

The heated pressurized air-gas mixture then flows into the turbine and does mechanical work on its rotating shaft. The air-gas mixture expands and cools as it gives up energy to do this work and then exhausts to the atmosphere. The turbine develops all the mechanical work of the cycle, part being used to drive the compressor; the remainder is net output of the cycle.

**Cycle analysis.** To simplify analysis we'll assume that the working fluid is air throughout the cycle, that is, we'll use an air standard. We'll regard the heat of combustion as heat energy transferred to the working fluid, $Q_a$. In Fig. 2 we analyze the operation of each element in terms of the steady-flow energy equation and assume the kinetic energy of the air stays constant throughout the cycle.

The lower three sketches of Fig. 2 give the P-V graphs for the compressor, turbine and total engine. The corresponding T-S graph for the cycle is in Fig. 1. Process *1-2* raises the air pressure and temperature at $S = C$ by absorbing work input $W_c$. Process *2-3* in the combustor raises the air temperature at $P = C$ by adding the cycle energy input $Q_a$. Process *3-4* in the turbine develops the gross mechanical work $W_t$ by expanding the air at $S = C$. Lower part of Fig. 2 shows that the compressor absorbs the major part of the gross work developed by the turbine.

An actual engine works with a continuously changing mass of air, but to simplify we'll assume the turbine exhaust air cools in flowing through the atmosphere, giving up rejected heat $Q_r$, and re-enters compressor intake to form an equivalent closed cycle. Summarizing all the energy transfers under CYCLE, Fig. 2, we see that ideally and actually $W = Q_a - Q_r$. The ENERGY FLOW sketch shows that the compressor circulates a relatively large amount of energy through the cycle.

Equation (22) of Fig. 2 gives the cycle thermal efficiency in terms of the air temperatures. A more practical method gives the thermal efficiency in terms of the pressure ratio of the cycle:

$$P_r = \frac{P_2}{P_1} = \frac{P_3}{P_4} \tag{1}$$

For the isentropic processes (Part 8, POWER, May 1957, p 108) temperatures and pressures are related by:

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} = P_r^{\frac{k-1}{k}} \tag{2}$$

$$\frac{T_3}{T_4} = \left(\frac{P_3}{P_4}\right)^{\frac{k-1}{k}} = P_r^{\frac{k-1}{k}} = \frac{T_2}{T_1} \tag{3}$$

Transposing the temperature ratios:

$$\frac{T_4}{T_1} = \frac{T_3}{T_2} \tag{4}$$

Subtracting 1 from each side we get:

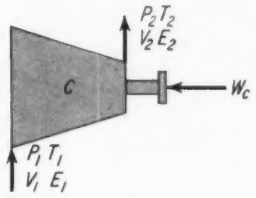
$$\frac{T_4}{T_1} - 1 = \frac{T_3}{T_2} - 1 \tag{5}$$

$$\frac{T_4 - T_1}{T_1} = \frac{T_3 - T_2}{T_2} \tag{6}$$

$$\frac{T_4 - T_1}{T_3 - T_2} = \frac{T_1}{T_2} = \frac{1}{P_r^{\frac{k-1}{k}}} \tag{7}$$

continued on page 152

## COMPRESSOR



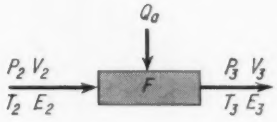

(1) $\frac{P_1 V_1}{J} + E_1 + W_c = \frac{P_2 V_2}{J} + E_2$

(2) $H_1 + W_c = H_2$

(3) $W_c = H_2 - H_1$

(4) $W_c = c_p (T_2 - T_1)$

## COMBUSTOR



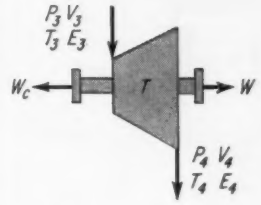

(5) $\frac{P_2 V_2}{J} + E_2 + Q_a = \frac{P_3 V_3}{J} + E_3$

(6) $H_2 + Q_a = H_3$

(7) $Q_a = H_3 - H_2$

(8) $Q_a = c_p (T_2 - T_3)$

## TURBINE



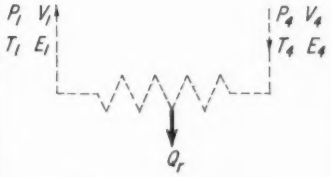

(9) $\frac{P_3 V_3}{J} + E_3 = \frac{P_4 V_4}{J} + E_4 + W_c + W$

(10) $H_3 = H_4 + W_c + W$

(11) $W = H_3 - H_4 - W_c$

(12) $W = H_3 - H_4 - H_2 + H_1 = c_p (T_3 - T_4 - T_2 + T_1)$

## HEAT REJECTED



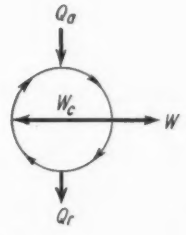

(13) $\frac{P_4 V_4}{J} + E_4 = \frac{P_1 V_1}{J} + E_1 + Q_r$

(14) $H_4 = H_1 + Q_r$

(15) $Q_r = H_4 - H_1$

(16) $Q_r = c_p (T_4 - T_1)$

## CYCLE

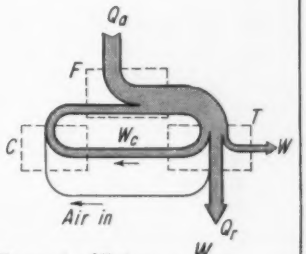



(17) $Q_a = W + Q_r$

(18) $W = Q_a - Q_r = H_3 - H_2 - (H_4 - H_1)$

(19) $W = c_p (T_3 - T_4 - T_2 + T_1)$

## ENERGY FLOW

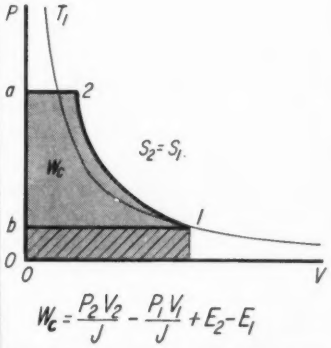



(20) Thermal efficiency $= \frac{W}{Q_a}$

(21) $= \frac{c_p (T_3 - T_4 - T_2 + T_1)}{c_p (T_3 - T_2)}$

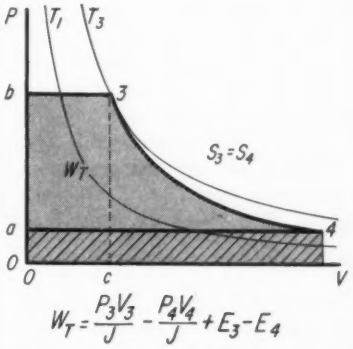
(22) $= 1 - \frac{T_4 - T_1}{T_3 - T_2}$

## COMPRESSOR WORK



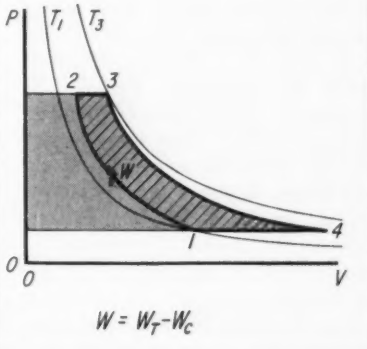

$W_c = \frac{P_2 V_2}{J} - \frac{P_1 V_1}{J} + E_2 - E_1$

## TURBINE WORK



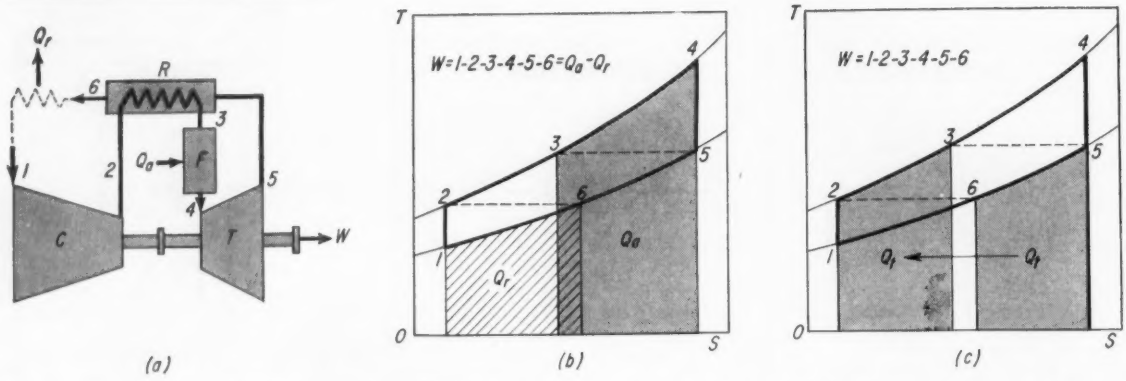

$W_T = \frac{P_3 V_3}{J} - \frac{P_4 V_4}{J} + E_3 - E_4$

## WORK OUTPUT




$W = W_T - W_c$

**2** Steady-flow energy analysis of each element of the gas-turbine engine shows how they fit together to develop net work output from heat input. P-V graphs for compressor, turbine and total unit correlate with T-S graph in Fig. 1, show work distribution




**3** Regenerative gas-turbine cycle passes turbine exhaust through heat exchanger $R$ to heat pressurized air entering combustor. The circulated energy $Q_t$ of graph (c) helps reduce both heat added and rejected to improve overall thermal efficiency of cycle

Substituting in equation (22) of Fig. 2 we get:

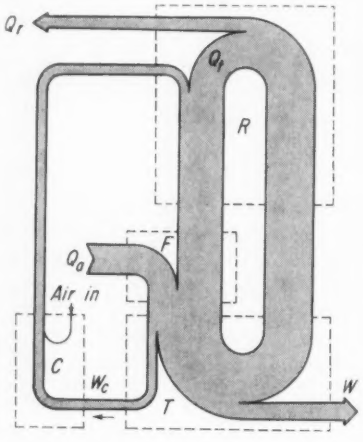
$$\text{Thermal eff} = 1 - \frac{1}{P_r^{\frac{k-1}{k}}} \qquad (8)$$

Process-wise the gas-turbine cycle is the same as the Joule or Brayton cycle (Part 13, Nov 1957, p 92) developed for reciprocating engines. Fig. 3 of Part 13 shows how the thermal efficiency of the cycle varies with pressure ratio. It also shows that the work output of the cycle reaches a maximum at a certain pressure and temperature ratio.

**Regenerative cycle.** The T-S graph, Fig. 1, shows that heat is added and rejected from the gas-turbine cycle at temperatures varying over a wide range. The Carnot principle shows that to achieve high efficiency we must absorb $Q_a$ at the highest possible level and reject $Q_r$ at lowest possible level.

We can do something about this by noting that most practical gas-turbine engines exhaust their gas at temperatures higher than the air discharged by the compressor before it enters the combustor, Fig. 1. By passing the air circuit through a heat exchanger called a *regenerator* we can heat the air to the exhaust temperature before it enters the combustor, Fig. 3. Ideally, the turbine exhaust cools to the exhaust temperature of the compressor. This makes $T_3 = T_5$ and $T_6 = T_2$.

Fig. 3*c* shows that the heat given up by the exhaust gas equals the heat picked up by the compressed air. The two areas marked $Q_t$ measure the heat transferred in the regenerator. The




**4** Energy flow diagram for regenerative gas-turbine cycle has large quantity of energy recirculating within cycle

right-hand area shows the amount of rejected heat saved by recirculating it in the cycle. The left-hand area shows the reduction in cycle heat input $Q_a$.

Fig. 3*b* shows the heat added and rejected in the regenerative gas-turbine cycle. Compared with the simple cycle in Fig. 1, note that the average temperature of heat addition from $T_3$ to $T_4$ has been raised in Fig. 3*b* and the average temperature of heat rejection from $T_6$ to $T_1$ has been lowered. This raises the cycle thermal efficiency.

The net work of the cycle $W$ = area *1-2-3-4-5-6* even though the areas for $Q_a$ and $Q_r$ are not coincident. This follows from:

$$W = Q_a + Q_t - (Q_r + Q_t)$$
$$= Q_a - Q_r \qquad (9)$$

Next let us find the efficiency for this improved cycle:

$$e = \frac{W}{Q_a} = \frac{Q_a - Q_r}{Q_a} = 1 - \frac{Q_r}{Q_a}$$
$$= 1 - \frac{c_p(T_6 - T_1)}{c_p(T_4 - T_3)}$$
$$= 1 - \frac{T_2 - T_1}{T_4 - T_5}$$

Multiplying the numerator of the fraction by $T_1/T_1$ and the denominator by $T_4/T_4$ we get:

$$e = 1 - \frac{T_1}{T_4}\frac{\frac{T_2}{T_1} - 1}{1 - \frac{T_5}{T_4}}$$

But $$\frac{T_2}{T_1} = \frac{T_4}{T_5} = P_r^{\frac{k-1}{k}} = A$$

Then substituting:

$$e = 1 - \frac{T_1}{T_4}\frac{A - 1}{1 - \frac{1}{A}} = 1 - \frac{T_1}{T_4}A$$

$$e = 1 - \frac{T_1}{T_4}P_r^{\frac{k-1}{k}}$$

Fig. 3 of Part 13, Nov 1957, shows how the regenerative thermal efficiency varies with pressure ratio.

Fig. 4 shows the energy-flow diagram for an ideal regenerative cycle. The recirculated energy $Q_t$ is of the same order of magnitude as $Q_a$.

When irreversibilities are taken into account, cycle thermal efficiencies are considerably lower. For practical performances see *Electric Generation—Hydro, Diesel and Gas-Turbine Stations* by Skrotzki, pp 407-417. These cycles also use intercooled compression and reheating.

*Next part deals with actual performance of compressors and turbines.*

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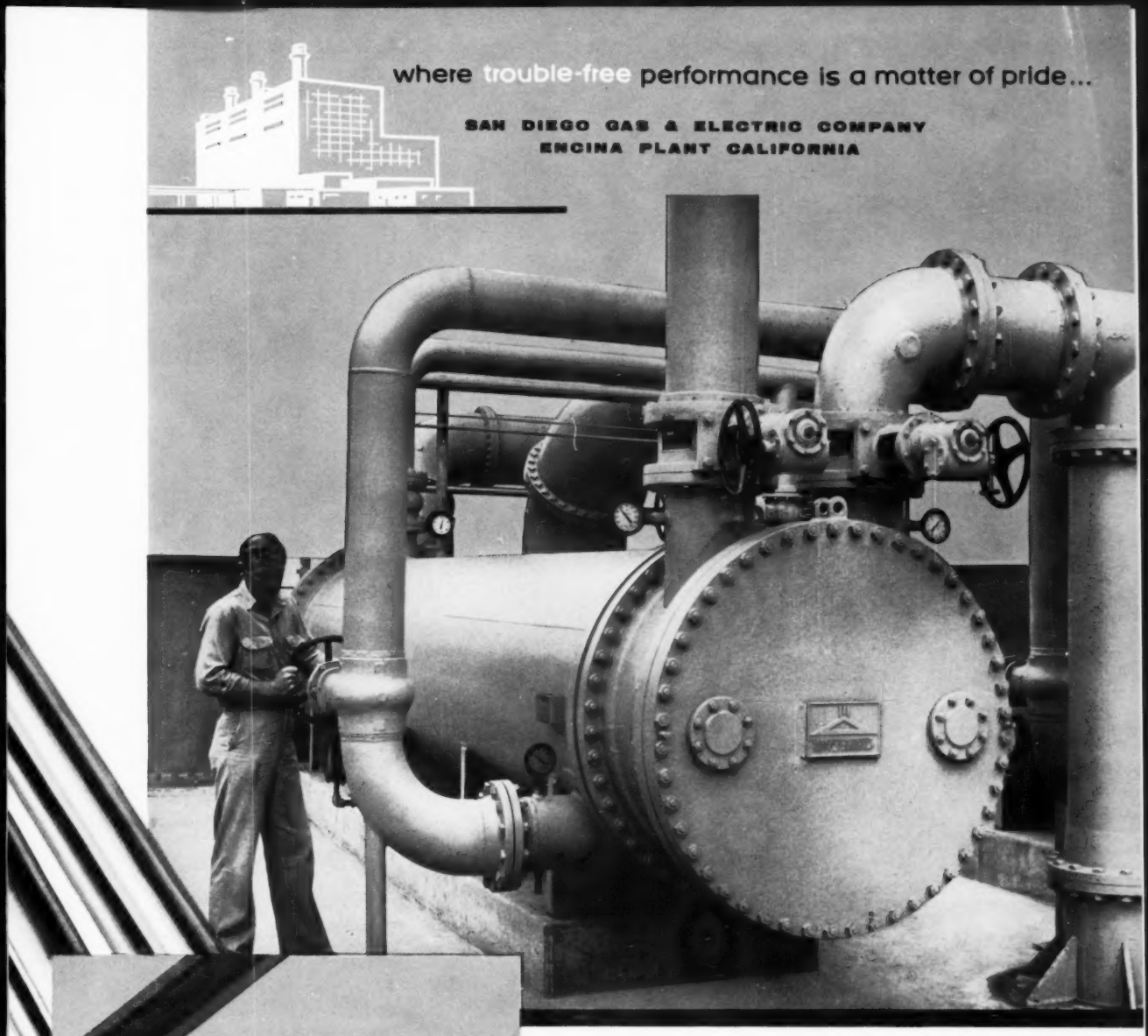

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*Engineering Campus, McDonnell Aircraft Corporation, St. Louis. Harris Armstrong, architect; Belt & Given, mechanical engineers; MacDonald Construction Co., general contractor; T. J. Sheehan Co. and Sodemann Heat & Power Co., mechanical contractors; all of St. Louis.*

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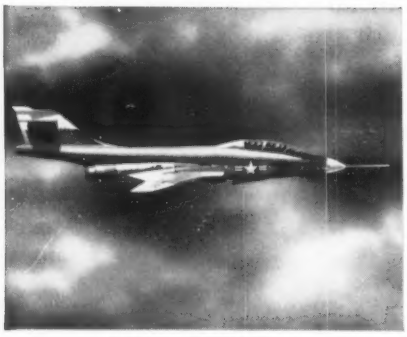

McDonnell F-101B Voodoo

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# Steel stack is protected from corrosion by concrete lining made with **Atlas Lumnite Cement**

At Pennsylvania Power Company (New Castle, Pa.) this stack interior was recently gunited with a mixture of Lumnite calcium-aluminate cement and sand aggregate.

This monolithic concrete lining will protect the stack from corrosion, abrasion and high temperatures.

Concrete made with Lumnite cement can be cast in place, plastered against the shell or gunited. It reaches high strength in 24 hours.

For convenience, manufacturers of refractories offer castables bonded with Lumnite cement – packaged mixtures ready for use with just the addition of water. For more information, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

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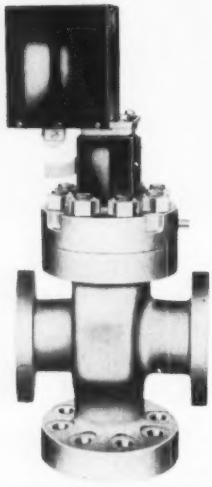
# PRESSURE LOADED SEATING

## minimizes leakage and maintenance



Consolidated Electromatic Relief Valve. Sizes: 2½" to 14". Pressures to 3000 psi. Temperatures to 1120°F. Double Outlet.

Consolidated Electromatic® Relief Valves save steam, pure water, fuel, and "wear and tear" on your spring-loaded valves. Pressure loaded seating permits closer adjustment between operating pressure and set point than in spring-loaded valves. Many Electromatics are used to purge superheaters for faster startups and as superheater vent valves. They greatly reduce chances of superheater damage when firing up a cold steam generator or banked boiler.

Pressure loaded seating is created by channeling steam from the pressure vessel around the Electromatic's exhaust and into its main and pilot valve chambers. Steam pressure in both chambers always matches that in the vessel when the Electromatic is closed.

When pressure exceeds the Electromatic's set point, a signal from controller to panelboard control station results in solenoid thrust that opens the pilot valve, venting the steam faster than it can enter the pilot valve chamber through the clearance between the main valve disc and guide. With pressure in the chambers unbalanced, the main valve opens; steam exhausts until boiler pressure is reduced to the pre-determined setting of the controller. The pilot valve and the main valve close instantly at this point. Action is so fast, the closely adjusted Consolidated Electromatic normally relieves overpressure before the spring-loaded valve's set point is reached. For automatic or manual operation or to cut the valve out of service, a switch is provided on the control station. Send for Bulletin 720.

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For more facts circle 298 on Reader Service Card, p 117 ➤

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A small group of multi-purpose lubricants, organized by Texaco into a simplified plan, is rapidly replacing numerous specialty products in auxiliary power equipment applications.

As a result of this plan, inventory is cut sharply; storage space is saved. Misapplication dangers are substantially reduced. Lubrication rounds take less time—labor costs go down.

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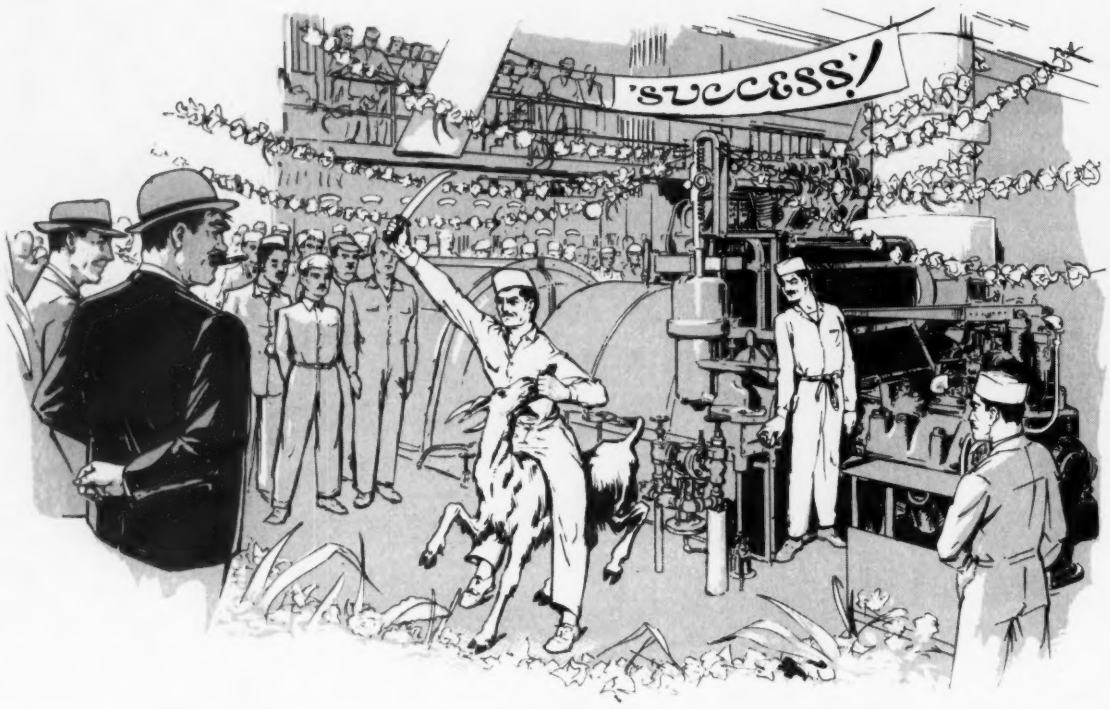



"Zakho strode forward majestically and straddled the goat amidships," guffawed Marmaduke

# Marmy's one-squirt Divriki

"BILGEWATER on dedications," roared Marmaduke Surfaceblow in his foghorn voice. "I'll tell you armchair engineers about a dedication that almost turned out to be the plant's requiem."

This blast took place yesterday while I was having a corned beef and cabbage luncheon at the Bent Propeller Bar, famous waterfront hangout. Effect of Marmy's sudden explosion was immediate and complete. It seemed that the earth itself had stopped spinning. What had been a raucous babble of voices suddenly turned into the stillness of a tomb. Only thing important was that the cantankerous old fox of a consulting engineer was about to sound off, so every word must be heard.

Thus suddenly propelled into the limelight, the old gent stood at the crowded bar, his 6-ft 4-in. frame straight as an arrow, with his battered gray derby crowning his shock of unruly hair. Marmy leisurely put down his bottle of Sandpaper Gin and turned his back to the bar. Then, surveying his audience deliberately, he hooked his huge thumbs into the armpits of his checkered vest. Satisfied he had the undivided attention of us mortal earthlings, he began to sound off with a blast that shook the bar.

"Now hear this," he roared. "Back in 1947 I was installation engineer for an American manufacturer at a large industrial plant in Tabuzun, Dhekire. We had just installed a steam turbine-generator unit. Soon as the new machine was running the top brass decided to celebrate Divriki to do homage to their local Goddess of Power.

"A week before the big day they started decorating with leaves, flowers and branches from sacred plants and trees. Seemed like acres of jungle were cleared of vegetation. The joint looked and smelled more like a giant greenhouse than any respectable power plant had a right to look and smell.

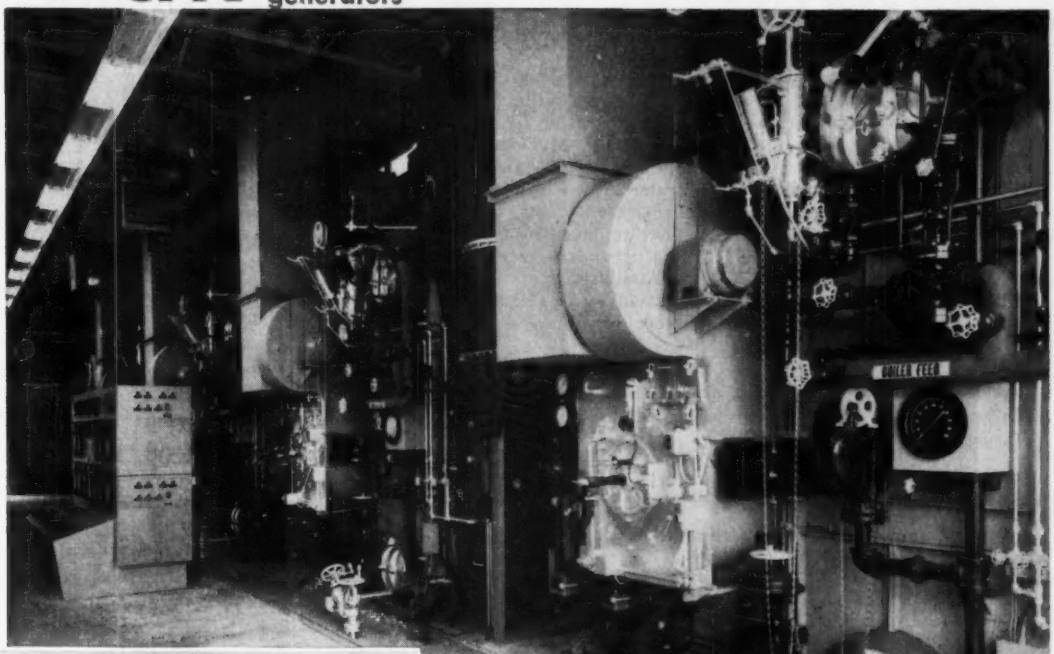
"Celebration was to be started off in the traditional way, by sacrificing a goat. The animal's carcass was then to be rationed out to the plant personnel to take home. But the important thing was to make the sacrifice according to Hoyle. That called for someone to straddle the goat amidships and, facing forward, to yank back the animal's head with his left hand while using his right hand to slash the goat's throat with a sharp ceremonial knife. Zab Zakho, the chief engineer, was to do the honors, with Amar Azizlya, the chief electrician, assisting with the proceedings.

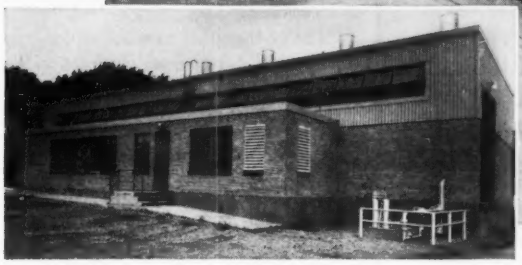
"When the great day arrived everyone from miles around showed up, including the village officials. Because the sacrifice had to take place inside the powerhouse next to the new unit, there was standing room only.

"Everyone was in a festive mood. The great moment arrived. Zakho

KEELER **dk** package steam generators

**THE HASKELL INSTITUTE—Lawrence, Kansas**
U. S. Government Indian School operated by
United States Department of the Interior, Bureau of Indian Affairs
Washington, D. C.
Arthur O. Allen, Engineering Advisor





**THE JIM THORPE POWER PLANT**
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BUREAU OF INDIAN AFFAIRS, BRANCH OF PLANT DESIGN & CONSTRUCTION, ALBUQUERQUE, N. M.
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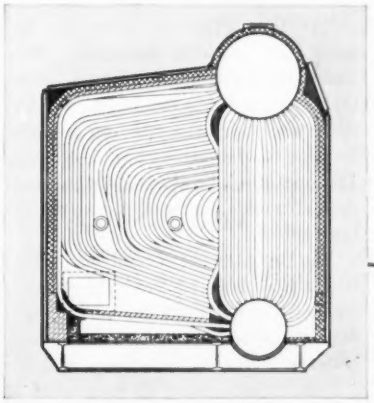

With an eye for economy and efficiency, the new central heating plant at the Haskell Institute is equipped with four multi-purpose Keeler Type D K package steam generators. They supply the entire steam needs of the several buildings at this U. S. Government Indian School located on a 280-acre tract near Kansas City.

Three of the units are 25,000-lb stm/hr capacity boilers equipped for combination oil and gas firing, and the fourth is an 18,000-lb stm/hr gas-fired unit.

A *"better efficiency than required"* report confirms the wisdom of the selection, together with further statements which indicate *a 20% drop in fuel costs,* when firing the new Keeler Type D K units at the same capacity as the previous equipment.

There's a size and type Keeler steam generator available for your requirements—up to 200,000-lbs stm/hr—with the full economy, efficiency, versatility and dependability that has earned Keeler its reputation as "builders of better boilers since 1864"! *Write or phone for free bulletins, full data and specifications . . .*

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KEELER WATER TUBE Boilers



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The drawing shows the simple hook-up. McDonnell No. 150 controls the boiler feed as it should be controlled—directly from the boiler water level. This holds the water level within the close limits that assure maximum steaming efficiency and fuel economy. Any deficiency in the returns is at once replaced by the McDonnell No. 27T Make-up Water Feeder installed on the receiver.

An extra switch on the No. 150 provides circuits for cutting off burner and sounding low water alarm—a final safeguard from emergency conditions such as current interruption in the pump circuit or failure of make-up supply.

*Ask for engineering data covering all conditions. For boilers up to 250 psi. ask about the new 92 Series Pump Control.*

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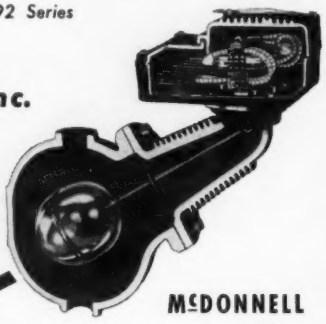
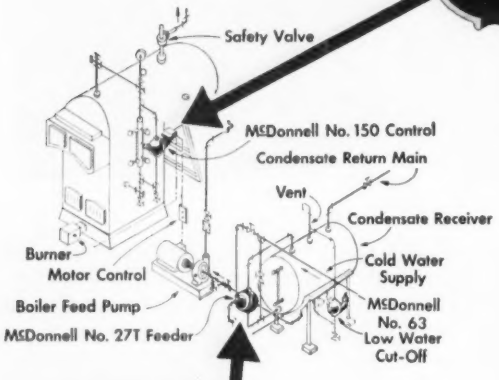
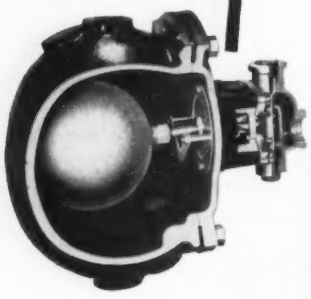





**McDONNELL No. 150 PUMP CONTROL**

The most widely used, time proved control of its type—for boilers up to 150 psi. Underwriters' Listed. Has two mercury switches—one for controlling feed pump and one for low water cut-off and alarm. Packless construction features heavy monel sylphon. Switch leads have porcelain bead insulation. Also available with water column type body—No. 157.



**McDONNELL No. 27T MAKE-UP WATER FEEDER**

Has large water feeding capacity which permits locating the No. 27T at a relatively low point on the receiving tank; this provides adequate space for return condensate, preventing wasteful overflow. Sturdy construction withstands turbulence in receiver. For tank pressures to 35 lbs., water supply pressures to 100 lbs. McDonnell Make-up Feeders also include flange-mounted types.

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**Flow Switches • Related Liquid Level Controls for Tanks, Stills, Air Conditioning Systems**


## Marmaduke

*Continued from page 158*

strode forward majestically, waving his goat sticker. Then, straddling the goat, he yanked the unhappy animal's head back by its chin whiskers and was about to slash its throat. But at that instant my native assistant, Hulbi Barmer, whipped a squirt can filled with carbon tetrachloride from behind his back. Taking deadly aim, he squirted at the goat's stern section. BULL'S EYE! That squirt started a chain reaction of events that no one present will forget.

"Being energized so unexpectedly, the goat took one mighty leap, heading in the direction of the Goddess Divriki's heavenly throne. Zakho suddenly found himself riding the goat for three mighty jumps. Then, just as suddenly, his chin hooked over a wire stretched across the room that was loaded down with decorations. The greatly surprised and most unfortunate chief crash-landed flat on his hull and conked out with the speed of a ruptured fuse.

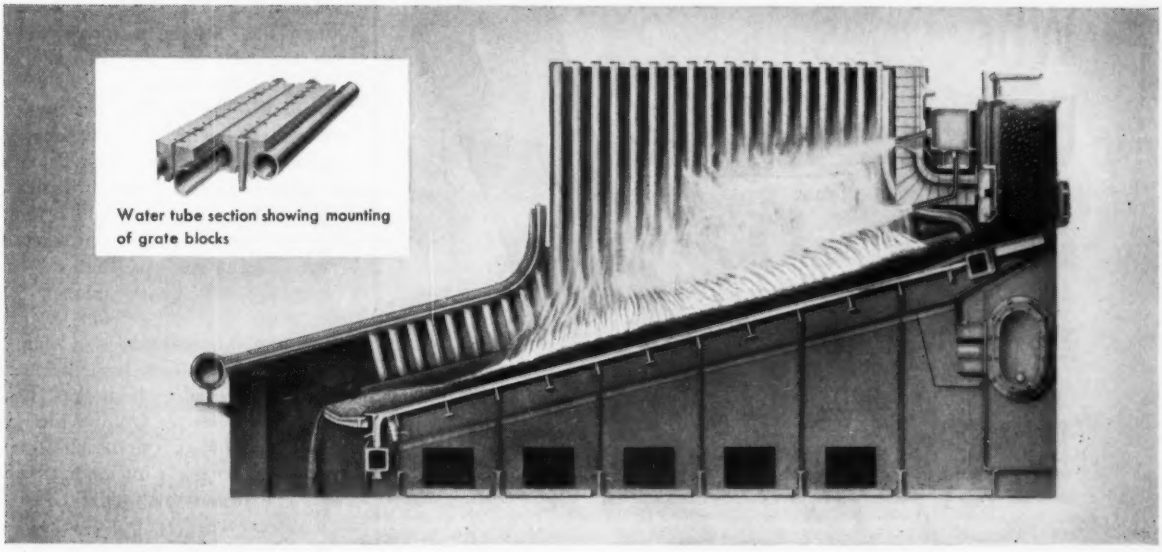
"The goat couldn't be bothered with Zakho, and cared less. He kept making knots, trying to escape from that carbon tet that was corroding his poop deck. About halfway to the other end of the building he aimed for a side window. But the main exciter set got in his way. By then the goat had too much steam up. He tried to stop, but his brakes wouldn't hold.

"That plant used one main exciter at a time for all five of its old machines. The exciter was driven by a small impulse shaft-coupling and generator brush-gear. The flying goat landed on a governor drive belt. The belt flew off and the belt safety started shutting down the unit, and the plant. Carbon brushes and pieces of goat went flying in all directions.

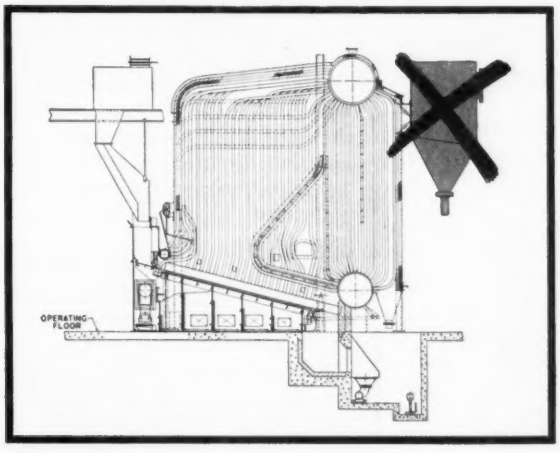
"At that exact moment the big crane was passing overhead. We'd had trouble just a few minutes before the ceremony was to begin, so had the crane pick up a welding machine to take to the far end of the plant. The operator's head was hanging over the cab's edge, as he stared at the doings below.

"As the goat got scrambled on that belt, a hind leg with the hoof attached zoomed through the air and caught the hypnotized crane operator smack between the eyes, knocking him for a loop. Down below all eyes were in

# Only AE Vibra-Grate Stokers give you these 3 important benefits




**Water-cooled grates.** Water-cooling . . . directly connected to the boiler circulation system . . . guarantees the longest grate life available in any stoker today. Proven maintenance costs are less than one cent per ton of coal. In fact, one major installation has used less than $200.00 worth of repair parts in over four years of continuous operation!




**Elimination of dust collectors** and cinder return systems. Vibra-Grate burns the coal on the grate . . . dust collection and cinder return systems are not needed. You will never have to be selective in the grade of coal you burn either. Vibra-Grate feeds wet or dry fuel, high or low grade coals. It can burn gas or oil singly or in combination with coal. Overfire air assures complete combustion, giving absolute freedom from smoke at high or low ratings.

**Higher efficiency.** Intermittent vibrating motion of the grate feeds and moves the fuel . . . insuring even, compact distribution on the bed. A combustion-controlled electric timer determines the vibration frequency as required by fuel and steam demand. There are no light spots or holes to reduce efficiency. The grate supports form air-tight zoned sections dampered to permit accurate regulation of undergrate air.

**THE AE VIBRA-GRATE** offers advantages in stoker operation and efficiency that have never been available before, because it is the only stoker which combines the maintenance saving features of water-cooling and the high efficiency features of a vibrating grate and controlled zone undergrate air. Only from Vibra-Grate can you get such dramatic reductions in maintenance costs . . . as well as efficiencies that can't be equalled. Write for complete information on what Vibra-Grate stokers can do for you in terms of lower operating costs.

**AMERICAN ENGINEERING COMPANY**
**Wheatsheaf Lane and Sepviva Street • Philadelphia 37, Pa.**

Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P. Q., Bawden Industries Ltd., Toronto, Ont.



For more facts circle 301 on Reader Service Card, p 117

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## Marmaduke

*Continued from page 160*

the goat's direction, so no one noticed the runaway crane until it hit the end of the runway with an earth-shaking crash. We noticed it then, all right.

"Upon crashing, the welding machine hanging on the hook swung violently out through a large window. Swinging back it hit the masonry column that separated the window from the next one and knocked it clear out of the wall.

"Below in the loading bay was a flatcar loaded with a dozen tons of cement in paper sacks. Those flatcars are called bogies in Tabuzun. Instead of air brakes, this bogie had a long lever on the side for the brakeman to set. The brake was released by kicking the dog, which snapped off the brakes.

"As luck would have it, a chunk of masonry from above landed smack on the dog, releasing the brakes. The loaded bogie started rolling slowly out of the powerhouse because the rails were downgrade for the first two miles. The switchyard was 300 yards from the powerhouse.

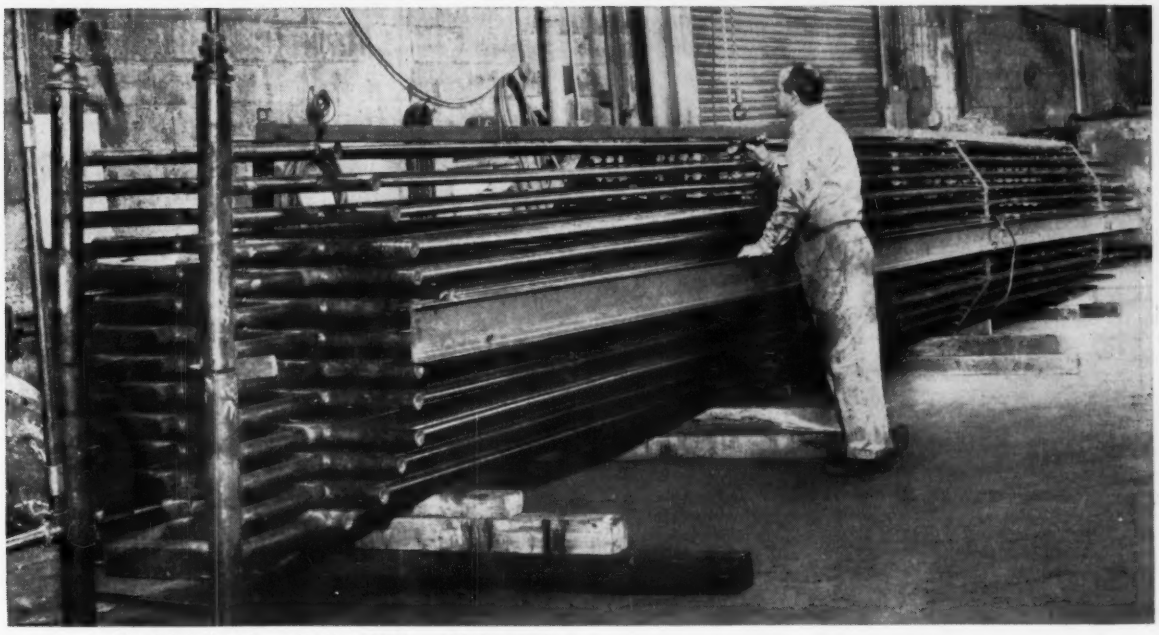
"By that time bedlam had really broken loose. As that runaway bogie built up speed, natives along the tracks ran for the jungle, shrieking their heads off. But just then we were horrified to see our big diesel locomotive come up the line, headed straight for the bogie. The diesel driver saw it too, but the bogie had picked up a 30-mile-per-hour speed and was shedding a few cement sacks at every bumpy rail joint for good measure. The diesel driver did the only sensible thing done by anyone that hectic day. He stopped, then started going astern to the first siding, about 200 yards down the line.

"All this time he excitedly jabbered instructions to his brakie, who jumped off, ran to the siding, threw the switch, then threw it back just as the bogie came hell bent for election. He just did make it in time. The bogie went zooming by, throwing cement sacks like rockets in every direction. One of the sacks shot through the cab window where it exploded, putting the diesel driver out of the show temporarily by snowing him under with cement dust. Now we had a runaway diesel. It rumbled to the end of the siding and, since a wooden tie acted as the only bumper, the lo-



For more facts circle 302 on Reader Service Card, p 117

# One good turn deserves 192 others!



Pipe fabricators: Cornell & Underhill, Inc., Hoboken, N. J.

**During fabrication,** the USS* NATIONAL Seamless Steel Tubes used in this 8-ton heat exchanger were turned, or bent, 193 times! What's more, fabrication involved 584 pipe welds of various types and 1,720 inches of fillet welding. Mainly, the 35-foot-long, 5-foot-high bundle consists of ¾-inch Schedule 80 NATIONAL* Seamless Pressure Tubes; fabricated for the Solvay Process Division of Allied Chemical & Dye Corporation.

NATIONAL Seamless Pipe and Tubes are known the world over for safety and dependability. They are available in carbon through the various alloy and stainless grades. Get the complete story by sending for Bulletins 10 and 26. And, for technical assistance, our Mill Service Force is available for field consultation. Write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

*USS and National are registered trademarks*

*"The world's largest and most experienced manufacturer of tubular products"*

**National Tube Division of USS United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors · United States Steel Supply Division
United States Steel Export Company, New York



For more facts circle 303 on Reader Service Card, p 117

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- Visible operating point indicators
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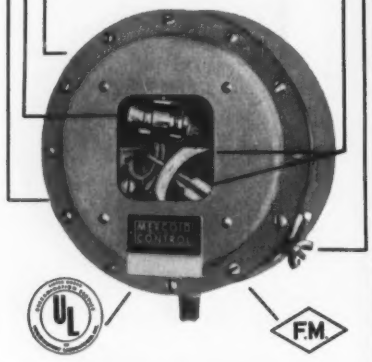


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4201 BELMONT AVE., CHICAGO 41, ILL.


## Marmaduke

Continued from page 162

comotive went right on through the carpenter shop and came to roost inside the foundry.

"But the bogie didn't stop. It headed merrily for the next town of Shatra at a good 60-mph clip. Last time we saw that missile she was zooming around a curve, shedding cement sacks like howitzer shells which exploded in big clouds of dust as they hit the ground.

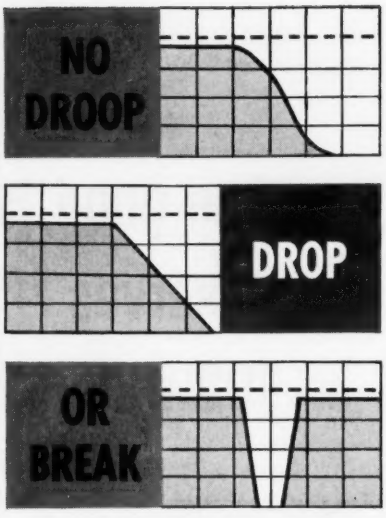
"We were still dumbfounded from all that had happened within a few minutes' time as that bogie disappeared around the bend. That, we thought was that. But no, for coming around the curve on the same track was a trolley car. Shades of Captain Kidd! And through the haze of dust there seemed to be, of all things, a cow sitting in the front seat. This was too much and I wondered whether I was nuts—or possibly delirious.

"Later, when things quieted down, the trolley driver told me what happened just before the car came around that bend. He said he had seen the bogie zoom around the curve, straight at him. He and the passengers didn't wait to learn why—they jumped. But lucky for them, the bogie jumped the track on a curve before reaching the trolley. Next thing the driver saw was the bogie rolling down the bank into the river.

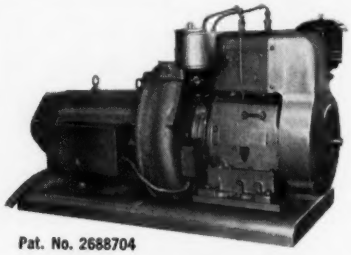
"There was such a cloud of cement dust that no one knew how the young Brahma bull came to park in the front seat. Maybe the crash of the bogie scared him, starting him across the tracks where the runaway trolley scooped him up.

"Sight of the trolley caused hell to really break loose. Everyone started throwing switches as the trolley came tearing into the switchyard with the bellowing bull in the driver's seat. Nobody seemed to know what he was doing. Idea seemed to be to do something, and do it fast. If they had done nothing, the trolley would have crashed in the loading bay of the powerhouse. But someone threw a switch, diverting the trolley into the other side of the powerhouse.

"Trouble with that was that the track lead alongside the transformer room and ended up against a loading dock in the far end. The plant office was directly at the end of the track. When the trolley hit the end of the


**in Communications with U. S. MICRO-POWER**



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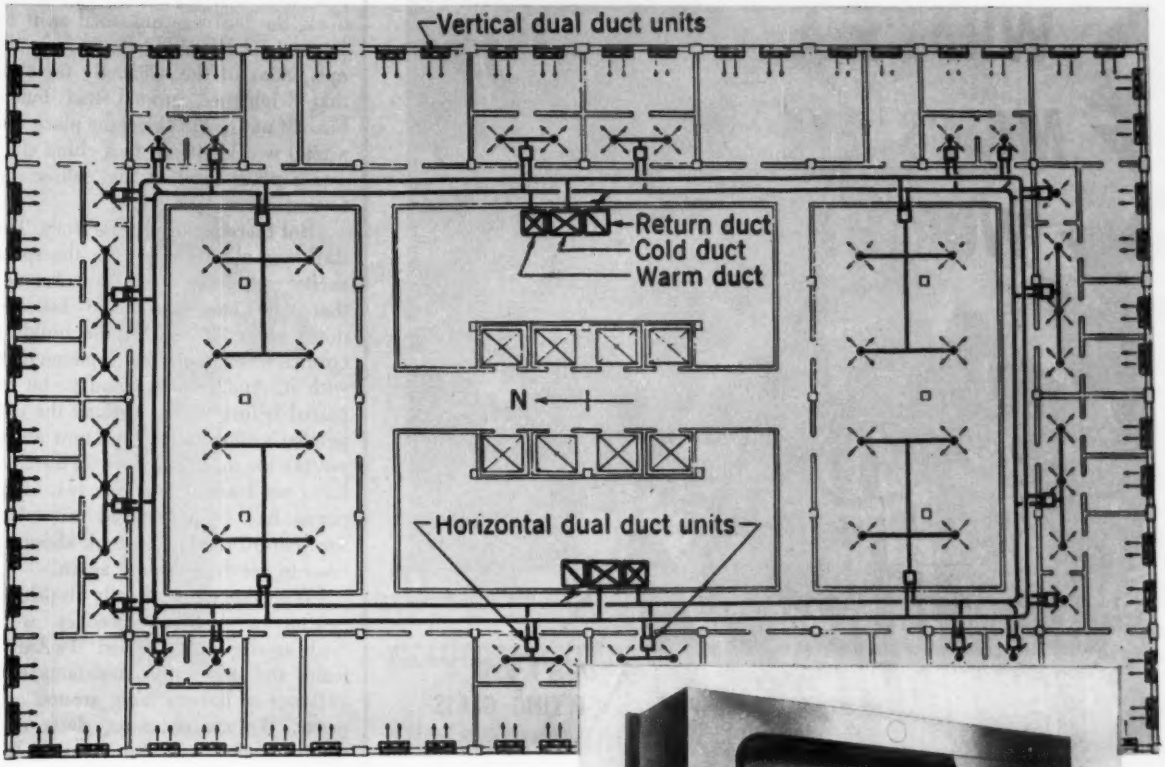
circle 304 on Reader Service Card, p 117

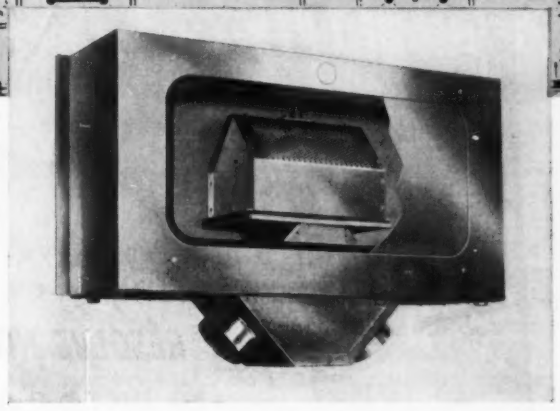
circle 305 on Reader Service Card, p 117

# HOW TO "BALANCE A BUILDING" BEFORE IT'S BUILT:




Shown above is a typical office building dual duct layout, 100 per cent air system. It is zoned to provide selective temperature control for each enclosure with Buensod vertical dual duct units at exterior walls. These under-window units may be connected to vertical risers, or to horizontal mains at the ceiling or on the floor below.

*Illustrated: Buensod Type V window-wall unit with cut-away showing automatic volume control. This unit is designed for installation under windows to discharge vertically upward, quietly and without draft.*



Balancing a building before it's built . . . almost an incongruity, yet Buensod does it consistently. Buensod air mixing units can be pre-set at the factory for desired volume and guaranteed within ±5% when installed. Whenever desired, a change in air volume may be made in the field by simple adjustment of one nut. This practically eliminates the tedious job of balancing after installation . . . a chore which can take months.

The secret is in Buensod's proven Automatic Volume Control. A simple tent-like apparatus maintains constant air quantity from each unit regardless of variance of static pressures on either inlet or outlet of mixing valve. This operates automatically . . . independent of any outside power source, sensing instrument or complicated linkage arrangement. The mixing valve is actuated by a local thermostat to provide the desired room temperature.

Buensod units are being designed into a constantly increasing number of new and renovated structures. Consider them for your next project.

# BUENSOD DUAL-DUCT

*Write for details to:* BUENSOD-STACEY

**Buensod-Stacey, Inc., 45 West 18 Street, New York 11, New York**



For more facts circle 306 on Reader Service Card, p 117

## Marmaduke

Continued from page 164

line and crashed into the loading dock, the bull was unloaded as if by jet action. He skidded through the open door of the office. By the time that frightened animal had bulled himself out of the office, the place was a total wreck. A bull in a china shop was a piker to what that fellow did to that office.

"But there's more to the story. The staff was hurriedly getting the spare exciter set going when they learned that the crane crash had knocked down about 30 feet of the building cornice which took the telephone lines with it. And the lines had to be repaired before they could call the dispatcher's office to let him know about putting the machines back on the line. Later we learned that our two other plants had been knocked out when we went off the line. It took about an hour to get things going again.

"With everything finally shipshape —after a fashion—speeches were made as originally planned. We Americans and our native assistants had garlands of flowers hung around our necks. We ate coconuts, dates and candy made from palm juice. We even chewed betel nut along with the natives.

"The diesel driver, in the meantime, was busy shaking cement dust out of his ears and the crane operator's noggin was being bandaged over a lump the size of a goose egg.

"As for chief engineer Zab Zakho, two months later when I left for the States, he was still talking in a hoarse whisper from having his vocal cords tied into a knot when his Adam's apple tangled with that taut wire."

—SME

### Marmy's Mailbox

MARMY BELONGS

Yes, Marmy sure does belong in print. He belongs because he's interesting, unpainfully informative, unconventional, refreshing. He belongs not only for what he represents, but because he enhances your magazine's "personality." I believe he helps the reception and readership of the more serious, straightline material you print. In other words, he's frosting to that wonderful cake of highly technical information known as POWER.

P DEGUZMAN, *New York, N. Y.*



For more facts circle 307 on Reader Service Card, p 117

## No other flow meter gives you the accuracy, convenience and economy of the new Honeywell Bellows Flow Meter

- **Calibrated accuracy ± 0.5% of full scale**
- **Leakproof between liquid fill and process fluid**
- **No mercury to contaminate process fluid**
- **No zero shift between —40 and +250°F**
- **Fast range changing in field; choice of fifteen ranges**
- **High corrosion resistance**
- **Fast, accurate damping adjustment**
- **Meter body is self-venting, draining or purging**

Here's the most advanced meter body available today for flow and liquid level metering. You can use it with virtually any process fluid, with combustible fluids, and in hazardous atmospheres. Meter body has connections for either vertical or horizontal piping. Remove it from the system for servicing without disturbing the piping.

Models available in many ranges, for both flow and liquid level measurement and control. Call your nearby Honeywell field engineer for details on the new Honeywell Bellows Meter. He's as near as your phone. Or write for Catalog C22-1.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

- **Reference Data: Write for Catalog C22-1 "Bellows Flow Meter".**

# Honeywell

First in Control



For more facts circle 308 on Reader Service Card, p 117

# Powerscope . . . A selective look at

## A world of wonders . . .

. . . that could change living patterns for all mankind will be explored by General Electric in new facilities at Schenectady, N.Y. slated for study of nuclear radiation. Extending in scope from earth to outer space, the studies are expected to be most thorough ever undertaken to explore effects of nuclear energy upon man's physical environment. Working with nuclear radiations that travel at speeds near that of light itself, that can "see" through concrete and turn wood into edible cellulose, GE engineers and scientists hope to spur the pursuit for practical knowledge and use of the world's most awesome forces.

**First completely automatic power plant—a $30 million unit—is under construction near New Orleans for Louisiana Power and Light Company. A computer-operated control system developed by Daystrom, Inc will supervise all functions of the new 225-mw unit—from startup through operation to shutdown, without human intervention.**

## Tapping the earth's marketplace

**American companies must establish manufacturing footholds in Europe's Common Market and the proposed Free Trade Area or face prospect of extinction in European and other world markets. This is what E H Cherniss, director of foreign operations for Beckman Instruments, Inc, told a meeting of the Foreign Trade Assoc. This, Cherniss said, is the only answer to mounting competition from foreign firms operating within sanctioned economic unions.**

*Meanwhile,* Westinghouse Electric Corporation called upon the Government to cancel the order for an English-built steam turbine-generator for TVA and to rule that the import of such electric power generators constitutes a threat to the national security. In so doing, the company warned that unless Government policy is thus changed, the TVA, by 1969, could have over half of its total power capacity dependent on foreign firms for maintenance and repairs—repairs that could be cut off entirely in case of war.

From McGraw-Hill's Tokyo News Bureau comes word that Hitachi, Ltd, Japan's leading maker of electrical equipment, has completed the last of two 83,000-kva 13,800-v 60-cycle ac generators for shipment to Brazil. Units are the largest the company has made for export, although a Hitachi-made generator with 93,000-kva capacity is installed at the Sakuma Dam site in Japan.

**Soviet news agency Tass reports world's largest 3-pole oil switch—a 500-kv unit—has been made by the Ural Factory for Electric Apparatus. It will be installed on the high-tension grid line linking Volga power plants with the Ural area. Until the 500-kv line is finished the switch will operate at 400 kv; it has capacity to switch up to 12,000,000 kva within 1/100th of a second.**

American Potash & Chemical Corporation will build the first large-scale commercial plant to produce boric oxide (boric acid anhydride). Boric oxide is used in manufacturing high-energy fuels, as well as various industrial applications.

Closed-circuit industrial TV is being installed for observations at the giant proton-synchrotron under construction at the European Nuclear Research Center, Geneva. Orders for two cameras, three receiving sets and some auxiliary equipment have been placed with the Belgian firm ACEC.

## Looking ahead

*ACI forecast:* Electric generation will easily top 700 billion kwhr in 1959. This represents an 8.6% gain from 1958, but only 10.8% from 1957. The 700 billion kwhr represents 308 million tons of coal equivalent at .88 lb per kwhr; estimating hydro at 20.5% and coal's percentage of all fuel at 69, coal consumption would be 169 million tons in electric generation.

**To increase overall efficiency of steam-cycle power-generating plants, and to provide power-generating facilities for the vast arid regions of the West, the U.S. Bureau of Mines is about to conduct R&D to establish feasibility of the coal-burning gas turbine for power generation in stationary plants. Program will take advantage of 12 years of R&D carried out by Locomotive Development Committee of Bituminous Coal Research, Inc.**

A 14-man advisory council representing major electric power systems of U.S. and Canada has been named to help guide Project EHV, GE's 5-yr experimental program in extra high-voltage power transmission. Construction is about to start on a 4½-mile transmission line near Pittsfield, Mass. to carry power at a maximum of 750,000 v (POWER,

# this month's power-field happenings

ART SOMMER, Assistant Editor

July 1958, p 93). The advisory committee will help in determining investigations and tests to be performed to reach these supervoltages in separate steps—starting at 460,000 v.

Twelve European countries have joined together in a $38 million program to investigate the use of high-temperature gas-cooled reactors for nuclear power stations. Project will center on construction of an experimental power-producing reactor at Winfrith Heath, research facility of the British Atomic Energy Authority. An international design team will draw up working plans. Design object: to get an outlet temperature high enough to operate modern steam-turbine-generating sets.

**Under a grant of $57,600 from the National Science Foundation, three U of Wisconsin engineers are about to launch a continued study of the process by which liquid fuels mix with air and become combustible in the combustion chambers of engines. Liquid fuels under study will be sprayed, their behavior under conditions simulating various types of combustion chambers will be photographed and the vaporization analyzed.**

## Suggestions pay off . . .

**. . . to the tune of $32,000 for two blast-furnace workers of U.S. Steel Corp's Gary works who suggested a way to recover molten iron from slag. This is highest suggestion award ever paid in American industry.**

. . . and an employee at GE's Pittsfield, Mass. plant is $5200 richer for his suggestion that cuts by more than 50% the time needed for demoisturization of core and coil unit in power transformers.

*Here's an idea that's paying off in other ways for a forward-looking Columbia U sophomore.* **While classmates hurriedly jot down a lecturer's blackboard notes, Roger Field just looks, listens and absorbs. At end of each session he calmly steps to the front of the room with his 35-mm camera and photographs the data. Result, says Roger, is that he saves energy that note-taking consumes while getting more accurate notes. It also allows him to concentrate more on the professor's verbal message. He uses the method mostly in science classes where errors in copying long mathematical problems or involved diagrams could be serious. Demand for prints from other students offsets cost.**

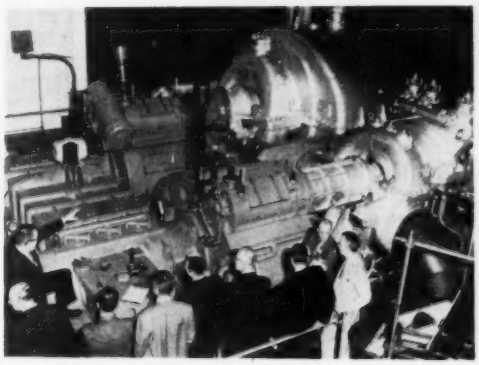
## Rock-and-roll craze . . .

. . . has invaded industry. But not in the form of an off-key melody. Rather, it's research to simulate actual sea conditions to test operating efficiency of distillation equipment for marine use. The Cleaver-Brooks test setup has been installed at their seaside research and test site, Wrightville Beach, N.C., where the company is studying sea desalting techniques.

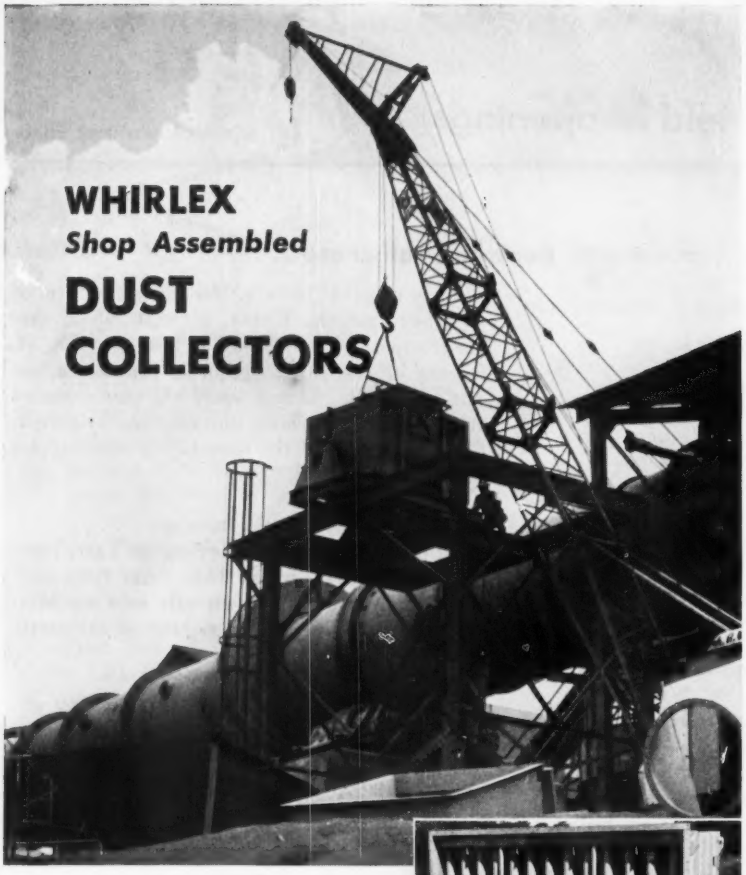
*Vocalizing "world first" claims are . . .*
**. . . the Soviets who, according to Tass, have designed and built the first "sun turbine," which converts the sun directly into mechanical energy. Unit utilizes energy of magnetic fields and sun's heat.**

. . . Westinghouse Electric Corp who say they will build the first gas-turbine electric power station with completely automatic remote controls. It will be used to power an oil storage and tanker-loading facility on Lake Maracaibo, Venezuela.

## Main propulsion machinery . . .



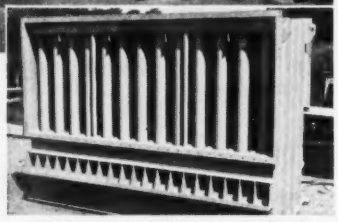
. . . for first atomic surface vessel, the N/S Savannah, is viewed by AEC and Maritime Administration officials and newsmen during initial shop tests at De Laval Steam Turbine Co. This machinery is capable of delivering 22,000 shaft hp and weighs about 350,000 lb. Main turbines and reduction gear, above, will be powered by steam produced in a pressurized-water reactor being constructed by The Babcock & Wilcox Co. Propulsion unit will turn the N/S Savannah's single propeller shaft at 106 rpm normal to maintain a normal speed of 20 knots. The atomic vessel with its crew of 120, accommodations for 60 passengers and a cargo of about 10,000 tons is expected to operate continuously for about 3½ years without refueling.



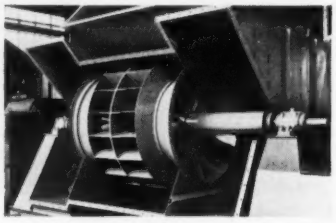

**. . . Cut Erection Costs to a Minimum**

This highly efficient Whirlex collector is completely shop assembled and need only be bolted in place at the erection site. Rigid shop inspection assures a "gas-tight" installation thus eliminating the opportunity of error at the job site.

*A Whirlex Shop-Assembled Dust Collector may be the answer to your problem. Write for more complete information.*



Whirlex Dust Collector completely fabricated and ready for shipment



Whirlex FD and ID fans are designed for heavy, rugged duty

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Forced Draft Fans • Exhaust Fans
Self Supporting Stacks • Duct Work

FLY ASH WHIRLEX ARRESTOR


## Reports from the field

### Reliance Gauge Column Co is 75 years old

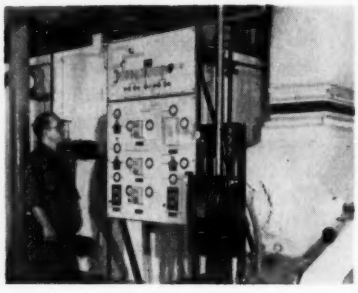
Back in 1884, when the first patent was issued on the "alarm" water column, pressures seldom exceeded 50 psi and the salesmen for the newly formed Reliance Gauge Co could carry a sample column to show their prospects in the power plants.

In the 75 years since then, pressures have gone to more than 5000 psi and boilers have become vastly larger. Many of the changes in water columns needed to meet these advances have been made by the Reliance Gauge Column Co, as the firm has been known since 1910.

Floats have been improved, gage valves and try cocks added, and gage inserts have given ability to stand pressures beyond the capabilities of tubular glass. Forged-steel bodies now clamp prismatic and mica-protected glass windows—even all-mica windows for some high-pressure boiler applications.

Visibility became a problem as boilers grew larger, and a series of design changes came as a result—illumination, vision-focusing hoods, reflector type hoods and, in 1936, the compensated hydrostatic remote-reading water-level indicator.

Recent years have seen development of isolated-electrode circuits for alarm and light-signal equipment.



### Picture panels add to air-conditioning efficiency

Graphic panels incorporated into the pneumatic control system can help simplify a building's air-condtiioning operation. In New York's Seagram Bldg, 23 central fan systems and four chilled-water systems have individual panels, each fitted out with a color-keyed portrait of the particular sys-


For more facts circle 309 on Reader Service Card, p 117

"FRANKLY HOPWOOD,

DON'T YOU THINK IT WOULD BE MUCH MORE PRACTICAL IF WE SENT FOR **BRIDGEPORT'S** FREE NEW BOOK— 'SOLVING CORROSION PROBLEMS IN INDUSTRY'!"

If you convey anything through condensers or heat exchangers, this 20-page Bridgeport book is must reading. It tells how to lick problems involving two corrosive media... by using bi-metal Duplex Tubes ...each metal surface designed to resist corrosion from the media to which it is exposed.

Each industry has its own corrosion problems, and this fact-packed book illustrates ways to solve many of them. For your personal copy, just write, on your company letterhead, to the Bridgeport Brass Company, Bridgeport 2, Connecticut. Please address Dept. 5404.

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For more facts circle 310 on Reader Service Card, p 117

# Are Entrainment Losses Stealing Your Profits?

# Centrifix®

**SCRUBBERS • PURIFIERS • SEPARATORS**

## Increase Your Profits!

1. Increases efficiency of existing equipment—get *more* production PLUS valuable by-products that help pay for this improvement.

2. Removes 99.5% or more of ALL solid or liquid entrainment in gas, air, steam or vapor regardless of density, chemical characteristics or size (even 1 micron or smaller).

3. Protects valuable capital equipment from costly shutdowns and major overhaul.

4. Reduces maintenance cost—no moving parts, no filters, non-clogging, self-cleaning.

5. Operates with MINIMUM pressure drop regardless of pressure, temperature or flow rate.

6. Easy to install—saves space, low cost.

AA-8240

FOR THE FINEST IN PURIFYING EQUIPMENT FOR STEAM—VAPOR—GAS—AIR

**Centrifix® CORPORATION**

**3608 PAYNE AVENUE**

**CLEVELAND 14, OHIO**

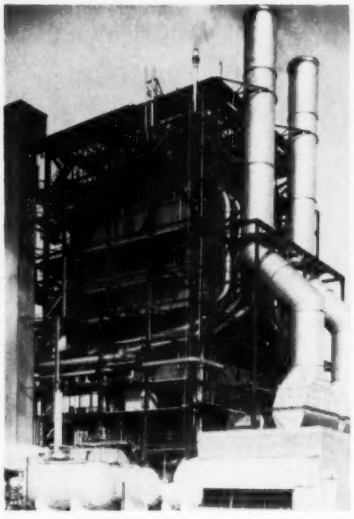
All Centrifix equipment is protected by U. S. Letters Patent & Patents Pending




Begins on page 170

tem, as well as control instruments, gages, etc. The pictures help give building personnel a clear understanding of the different systems.

Conditioned air for perimeter offices is supplied by a 3200-unit induction system. H-p dual duct systems serve interior zones and all offices are individually controlled. The 38-story skyscraper has 620,000 sq ft of rental space; 30 miles of compressed air piping went into its control system.



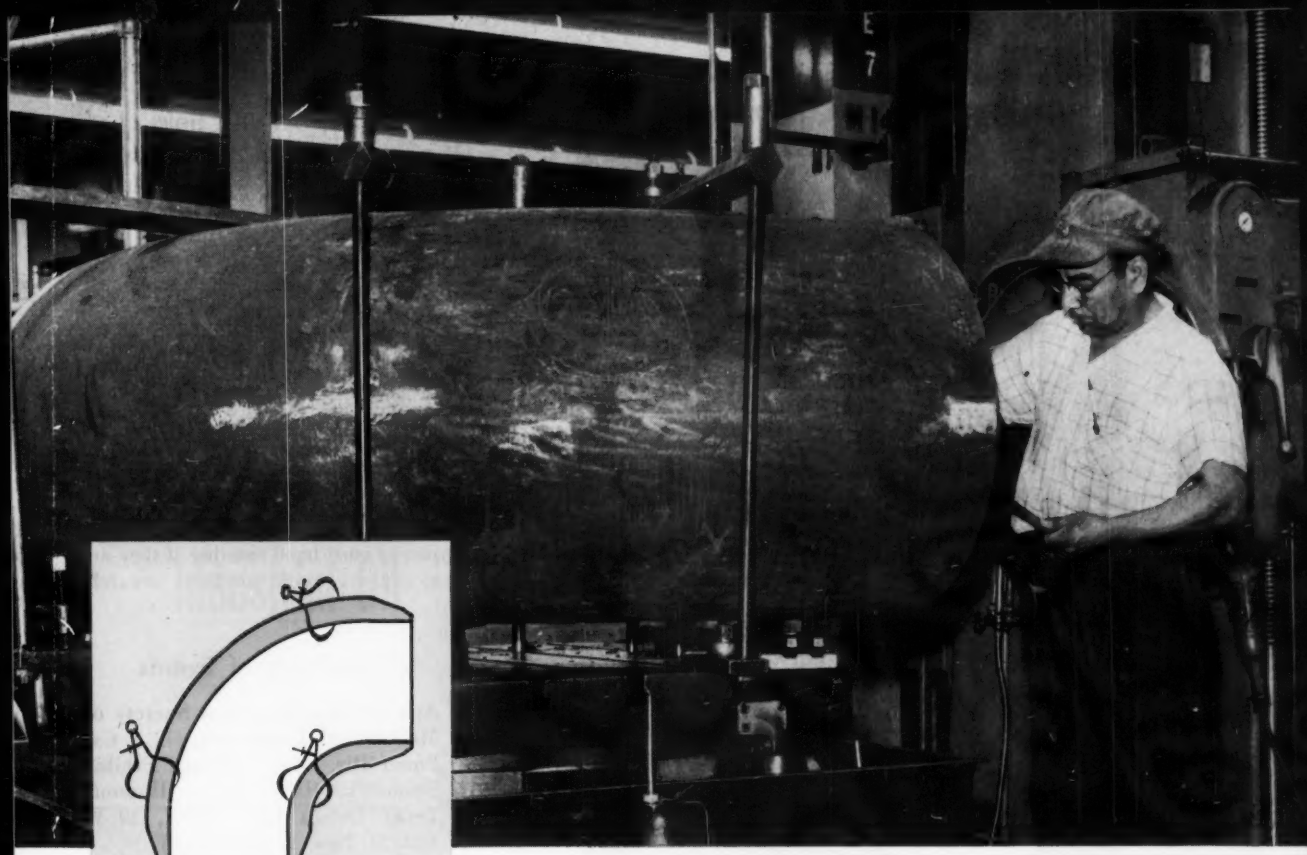
### Porcelain enamel makes a good skin for new boiler

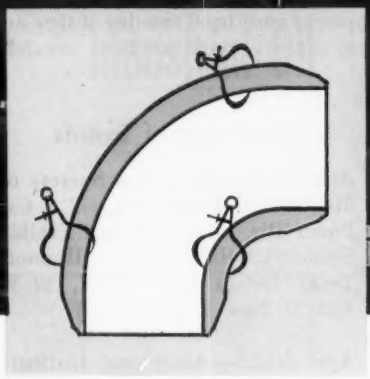
Bright, durable porcelain enamel is in use in Sterlington, La., where Louisiana Power & Light Company has erected a new 130-ft high boiler. Enamel was used for a complete roof over top of boiler. Sides were encased with enamel, and the material was worked into curvatures of preheaters and stack uptakes.

Design provides for expansion of 4½ in. in height. Material was prefabricated and porcelainized in the Avondale Marine Ways, Inc, Avoncraft Div's plant, to eliminate fitting in the field.

### Small-industry survival depends on cooperation

Cooperative basic-research laboratories may be small industry's only hope for future survival, according to L F





### Uniform Wall Elbows

Key-Kast Elbows have cast steel walls of a uniform thickness approximately 15% heavier than the required minimum thickness of pipe walls of the same I.D. For extra highly stressed line sections, the wall thickness and strength can be increased as much as desired — without sacrificing uniformity.

The flexibility of Key-Kast Elbows permit their use in piping systems based on the usual piping stress calculations. Write for engineering bulletin entitled **"Key-Kast Welding Elbows in Piping Stress Calculations."**

### Products of W-K-M's

*Creative Engineering*

Key-Kast Fittings can handle **any** piping job. Specify them. You'll get outstanding service.

# KEY-KAST®–the only cast elbows that meet all requirements for strength and flexibility

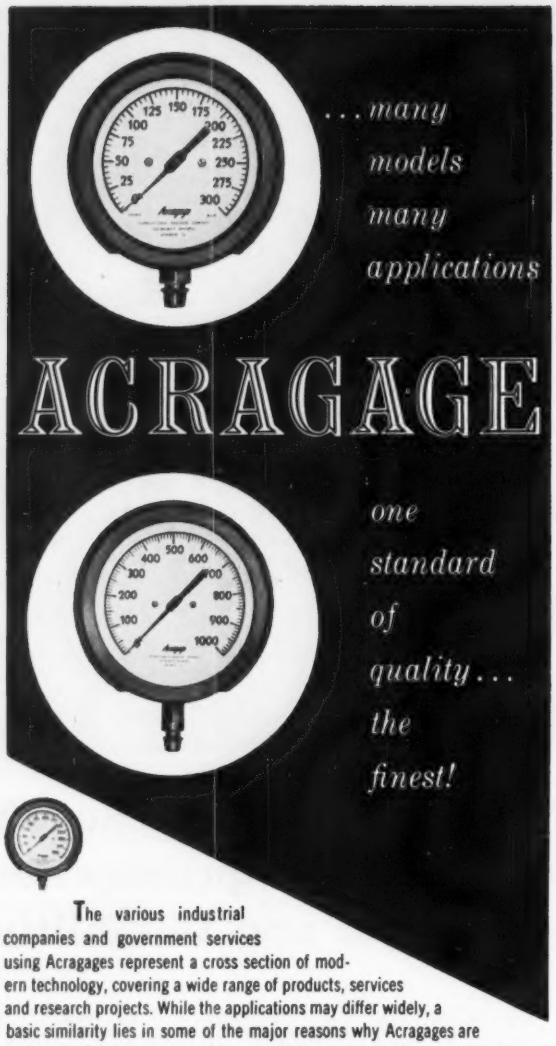
KEY-KAST *Uniform Wall* Alloy Steel Welding Elbows will give you outstanding service in any high pressure, high temperature alloy piping application. Only Key-Kast Elbows have cast steel walls of uniform thickness and strength — the most important factor in selecting the right fittings for your job.

Quality controlled through rigid metallurgical standards, Key-Kast Fittings meet ASTM specifications, and ASME and ASA code requirements. Specialists in fluid flow design these fittings to move your lading more safely and efficiently.

Call your Key-Kast representative for prompt, experienced service in selecting the Key-Kast Fitting best for you. Available in all standard shapes, sizes and schedules . . . or specially designed to meet specific conditions of pressure, temperature and lading. *W-K-M Division of ACF Industries, Incorporated, P. O. Box 2117, Houston, Texas.*

W-K-M 40 SERVING INDUSTRY YEARS
DIVISION OF ACF INDUSTRIES INCORPORATED

For more facts circle 312 on Reader Service Card, p 117




The various industrial companies and government services using Acragages represent a cross section of modern technology, covering a wide range of products, services and research projects. While the applications may differ widely, a basic similarity lies in some of the major reasons why Acragages are preferred: high accuracy, precision manufacture, fast and easy calibration, built-in safety, and assured dependability.

Acragages are the most advanced of the bourdon tube type pressure gage. Besides high accuracy, they feature solid front cases providing complete safety as well as quick and easy access to the bourdon tube assembly and internal mechanism for easy calibration. This solid front case feature is standard with Acragage . . . only one of a number of advancements typifying Acragage's development policy.

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Title_____

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## Reports from the field

*Begins on page 170*

Hickernell, president of the American Institute of Electrical Engineers. Speaking at the recent AIEE Winter General Meeting, Hickernell also called for formation of a central agency to code scientific and engineering literature, to avoid duplication of research.

The time is ending when small segments of industry can survive through applied research. Since basic industrial research costs $28,000 to $56,000 per scientist per year, small companies must band together if they are to support productive basic research.

## Calendar of Events

**Apr 19-23—American Society of Mechanical Engineers,** Oil & Gas Power Div, Conference and Exhibit. Shamrock - Hilton Hotel, Houston, Texas. Details from ASME, 29 W 39th St, New York 18, N. Y.

**Apr 20-21—American Institute of Electrical Engineers,** Recording & Controlling Instrumentation Committee, Third National Conference on Analog and Digital Instrumentation. Bellevue-Stratford Hotel, Philadelphia, Pa. Details from AIEE, 33 W 39th St, New York 18, N. Y.

**Apr 20-22 — Instrument Society of America,** Oak Ridge Section, Fifth Annual Southeastern Regional ISA Conference and Exhibit. Gatlinburg, Tenn. Details: J A Russell, 159 Athens Rd, Oak Ridge, Tenn.

**Apr 23-24—American Society of Mechanical Engineers** and **Society for the Advancement of Management,** Management Conference, Statler-Hilton Hotel, New York. Details from ASME, 29 W 39th St, New York 18, N. Y.

**Apr 25-May 1—1959 Industrial Health Conference.** Hotel Sherman, Chicago. Details: IHC, 28 E Jackson Blvd, Chicago 4, Ill.

**Apr 29-May 4—Oil-Heat Institute of America, Inc,** Annual Convention. Seattle, Washington. Details from OHI, 500 Fifth Ave, New York 36, N. Y.

**continued**



For more facts circle 313 on Reader Service Card, p 117

circle 314 on Reader Service Card, p 117 ➤

# Why Hunter Packing Company uses STANOIL Industrial Oil

Two reasons: (1) STANOIL is a superior oil. (2) Along with STANOIL, Hunter Packing receives experienced lubrication technical service.

A special antioxidant in STANOIL gives the oil resistance to *chemical* change. Deposits are minimized. The oil has a high viscosity index, is resistant to *temperature* change. It lubricates effectively at both high and low temperatures. Due to special refining techniques, STANOIL will not readily emulsify. A special additive minimizes foaming. STANOIL has a low pour point. It flows freely at low temperatures. A rust inhibitor in STANOIL "plates out" on metal surfaces.

W. P. "Sandy" Wehking, the Standard Oil man who calls on Hunter Packing Company, has plenty of experience in technical service work. He's been at it for 17 years. Sandy studied chemistry at Blackburn College. He has also completed the Standard Oil Sales Engineering School.

To get more information about STANOIL Industrial Oil and to obtain technical help on your lubrication problems, call the Standard Oil office near you in any of the 15 Midwest or Rocky Mountain states. Or write, **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

*Quick facts about* **STANOIL Industrial Oil**

- Antioxidant gives oil resistance to chemical change, minimizes deposits.
- Inhibitor "plates out" on metal surfaces, prevents corrosion.
- Receives special refining to eliminate emulsion problems. Contains additive to minimize foaming.
- High viscosity index. Resists temperature change.

*You expect more from* **STANDARD** *and you get it!*

Temperature check. Frank Persson of Hunter Packing Company and Standard Oil lubrication specialist W. P. "Sandy" Wehking inspect one of four compressors in Hunter plant that uses STANOIL Industrial Oil.

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Union-type end connectors, full-flow, quick opening, non-porous, never stick or gall, lightweight. ½" to 4" I.P.S.

**CHECK VALVE**

*"Chem-Check"®*

Full-flow, designed for minimum of head loss. New principle of seat seal for high and low pressure. ½" to 2" I.P.S.

*"Chem-Cock"®*

**COCK VALVE**

Teflon sealed, non-sticking full-flow cock for corrosion-service applications. ⅛" and ¼" I.P.S. and hose connectors.

**NEEDLE VALVE**

*"Micro-Meter"®*

Precise metering control and recording of settings, non-scaling, gall-proof needle. Resists internal, external corrosion. ¼"N.P.T.

*"Micro-Flow"®*

**GLOBE VALVE**

Fast opening and closing Teflon seats assure positive, "non-stick" seating in corrosive and scaling conditions. ¼" N.P.T.

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Distributor stocks nationally.

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## Reports from the field

Begins on page 170

**May 3-6—Air-Conditioning and Refrigeration Institute,** Board and Annual Meeting. The Homestead, Hot Springs, Va. Details from ARI, 1346 Connecticut Ave, NW, Washington 6, D.C.

**May 4-5—American Society of Mechanical Engineers,** Maintenance & Plant Engineering Div, Conference. Edgewater Beach Hotel, Chicago, Ill. Details from ASME, 29 W 39th St, New York 18, N.Y.

**May 7—Armour Research Foundation,** Symposium on Corrosion Inhibitors, Theory and Mechanism. Illinois Institute of Technology, Chicago. Details: M J Jans, ARF, 10 W 35th St, Chicago 16, Ill.

**May 11-13—American Institute of Electrical Engineers,** Conference on Automation Techniques. Chicago, Ill. Details from AIEE, 33 W 39th St, New York 18, N. Y.

**May 11-13—Instrument Society of America,** National Power Instrumentation Symposium. Kansas City, Mo. Details from H H Johnson, Consolidated Edison Co of New York, 4 Irving Place, New York 3, N. Y.

**May 18-20—Instrument Society of America,** Fifth National Symposium on Instrumental Methods of Analysis. Shamrock-Hilton Hotel, Houston, Texas. Details from H S Kindler, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**May 25-27—Instrument Society of America,** National Telemetering Conference. Cosmopolitan Hotel, Denver, Colo. Details from R Schmidt, Avco Mfg Co, 201 Lowell St, Wilmington, Mass.

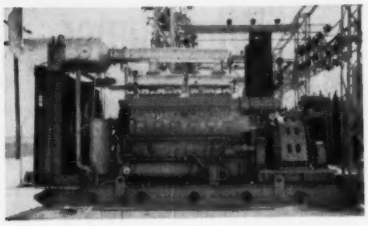
**May 25-29—National Fire Protection Association,** Annual Meeting. Atlantic City, N. J. Details from NFPA, 60 Batterymarch St, Boston 19, Mass.

**May 31-June 5—Columbia University School of Engineering,** Annual Industrial Research Conference. Arden House, Harriman, N. Y. Details: M Garvey, Columbia U, N.Y.C.

continued


*Advertisement*

## Peak power demands met with portable generators



Two portable diesel engine generator plants, rushed from the West Coast and installed all within 2 weeks, met an unprecedented peak-season demand for increased power on Florida Keys Electric Cooperative Association. The generators of 750kw and 300kw operating on a temporary basis at the association's Marathon plant were leased, shipped and installed by the A. G. Schoonmaker Company from Sausalito, California.

Diesel generators from 100kw to 1000kw are available from A. G. Schoonmaker Company on short term lease, long term lease or on a lease-option arrangement for installation anywhere in the world. Write for details.

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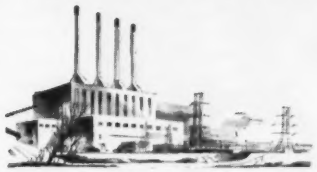
# YOU CAN DEPEND ON WOLVERINE CONDENSER TUBE—

## IT'S MADE THE TUBEMANSHIP WAY



From Wolverine Tube's years of experience in the heat transfer field has come tubing designed to meet *all* needs.

For example, when retubing surface condensers or feed water heaters, power engineers have a complete range of Wolverine prime surface tubing from which to select exactly the right copper alloy required to meet their operating conditions.

On the other hand, for such specialized applications as combustion air preheaters they can specify high-finned Wolverine Trufin Type H/A—the integrally finned condenser tube that has an outside to inside ratio of from approximately 8:1 to 16:1.

Providing the right tube for all types of applications is, however, but one of the many benefits Tubemanship brings to Wolverine customers. Thanks to Wolverine Tubemanship you are also assured of tubing that is backed by constant research, sound engineering and held to rigid specifications by statistical quality control.

Next time you order condenser tubing specify Wolverine—be sure of tubing manufactured the Tubemanship way. Write for complete information.

**Visit our exhibit, Booth 111—ATOMFAIR, April 5-10, Cleveland, Ohio**

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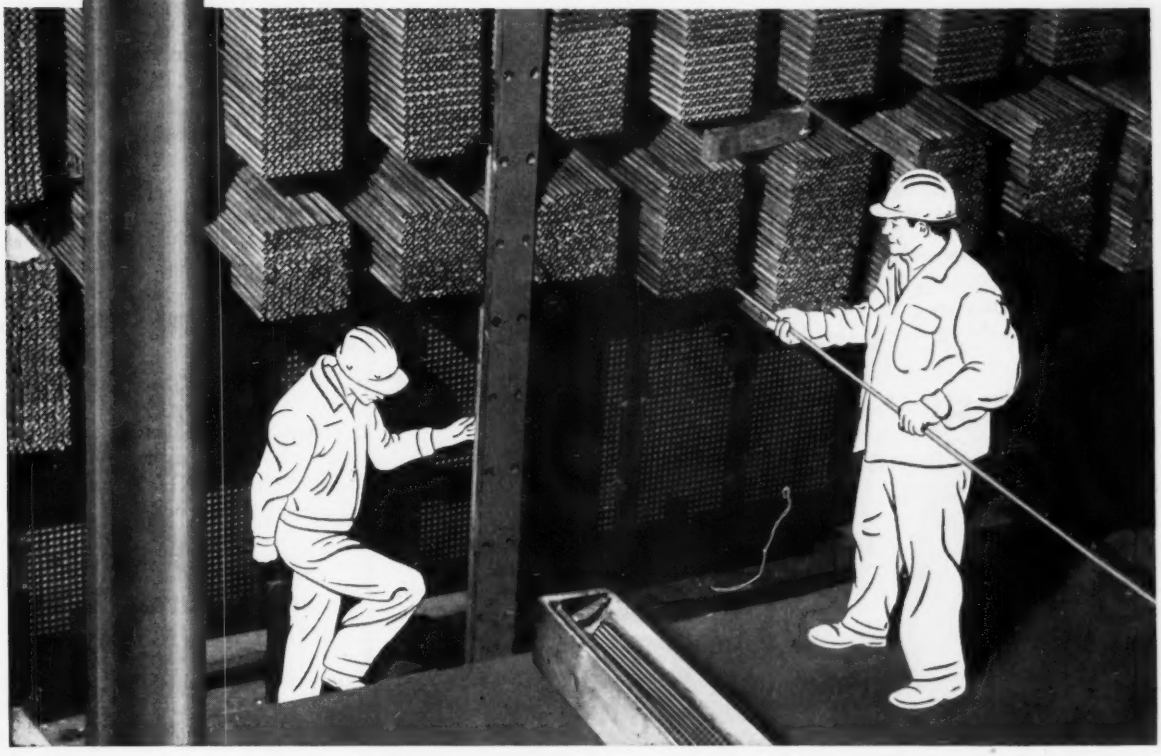




For more facts circle 318 on Reader Service Card, p 117

These two styles of Allpax Packing cover a wide range of applications and many different uses, consistent with the policy of our company—fewer packings for more services.

Both are compounded of the highest quality materials, and between them they cover against such service conditions as steam, water, air, ammonia, gases, oils, distillates, dowtherm, etc. They are for use on centrifugal and rotary pumps, valve stems, expansion joints and similar equipment.

Packaged in durable metal containers to insure protection and preservation of material. Applications and uses conveniently noted on each container.

**Style No. 1** is really universal in its uses—where the temperature does not exceed 600 degrees F.

**Style No. 2** also has an extremely wide variety of uses in higher temperatures, ranging from 600 degrees F. to 1200 degrees F. This is because of a special bonding compound, containing a heat-proof lubricant, which maintains the lubricant under high temperature conditions.

Both types are made in ring, spool or coil form in a wide variety of sizes. Allpax Packings do a better job for manufacturers and replacement use because they are precision-made, accurate in dimensions. They provide a tight seal without danger of scoring or unnecessary wear.

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## Reports from the field

Begins on page 170

**June 2-4—West Virginia University,** 1959 Appalachian Underground Corrosion Short Course. Morgantown, W. Va. Details from J H Alm, Room 605, Two Gateway Center, Pittsburgh 22, Pa.

**June 10-12—Instrument Society of America,** 2nd International Symposium on Gas Chromatography. East Lansing, Mich. Details from H S Kindler, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**June 14-18—American Society of Mechanical Engineers,** Semi-annual Meeting. Chase-Park Plaza Hotels, St. Louis, Mo. Details: ASME, 29 W 39th St, N. Y. 18, N. Y.

**June 15-19—New York University,** College of Engineering, course on thermoelectric materials. Details from Dr J P Nielsen, NYU College of Engineering, New York City, N.Y.

**June 18-20—American Society of Mechanical Engineers,** Applied Mechanics Div, Conference. Virginia Polytechnic Institute, Blacksburg, Va. Details from ASME, 29 W 39th St, New York 18, N. Y.

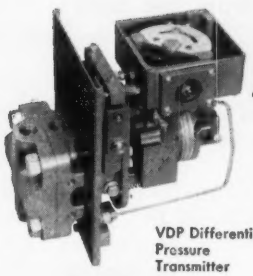
**June 22-26—Air Pollution Control Association,** Annual Meeting. Hotel Statler, Los Angeles, Calif. Details from APCA, 4400 Fifth Ave, Pittsburgh 13, Pa.

**June 24-26—Instrument Society of America,** 2nd Nuclear Instrumentation Symposium. Idaho Falls, Idaho. Details from H S Kindler, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

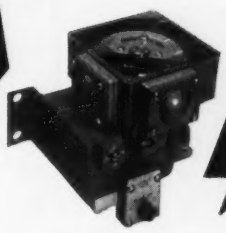
**June 29-July 3—New York University,** College of Engineering, course on ductile iron. Details from Dr J P Nielsen, NYU College of Engineering, New York City, N. Y.

### Creativity to hit peak soon: will Dark Ages follow?

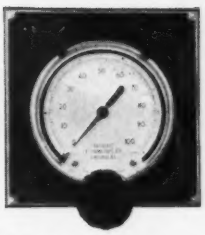
The scientific world will reach a peak of creativity 15 years from now. But a Dark Age can follow within a cen-



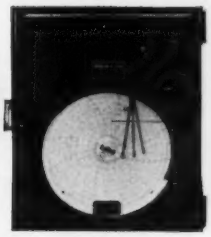
VDP Differential Pressure Transmitter



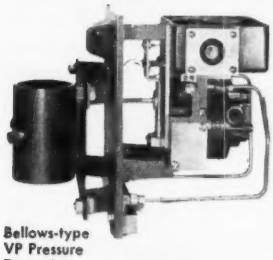
VC Controller



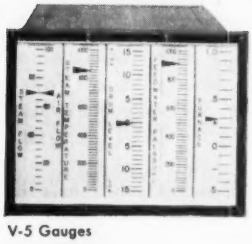
Type "A" Control Station



Flow, Pressure and Temperature Recorder



Bellows-type VP Pressure Transmitter



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Series 77S Final Drive

Diaphragm-type Angle Valve

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In order to fit your exact process control requirements, Republic now offers you a *complete* range of basic control components, which are (1) extremely accurate, (2) unusually versatile and (3) remarkably easy to combine into control systems.

For example: The differential pressure transmitter and controller illustrated are part of *a new family of pneumatic instruments*, developed to use the greatest possible number of *common* components. Because these Vector Series components can be interchanged—even among instruments performing entirely different *functions*—training and parts inventory are greatly simplified.

Radical changes in plant operating conditions present no problem when Vector instruments are used. Proportional band of the controller, for instance, is continuously adjustable from 2 to 500 per cent; the differential pressure transmitter has a range adjustment of 20 to 1, the pressure transmitter of as much as 10 to 1. Such adjustments are made simply by moving a link held by a lock screw. Re-zeroing is seldom needed.

Multi-point gauges with self-contained measuring elements are available for pressure, vacuum and differential. May also be used as receivers to indicate flow, $CO_2$, temperature or liquid level. Units may be grouped in any combination and substituted without disturbing other gauges. One- to four-pen recorders also available to measure these values.

Versatile Republic final drive units operate dampers, valves, inlet vanes and many other mechanisms. May be locally or remote controlled, by manual or automatic means. Proportionality of signal response can be tailored by a cam shaped on the job.

These are only a few of the many reasons why it is well worth while to consider versatile Republic components for your next (or existing!) control system. Your nearest Republic Sales Office will be delighted to assist . . . or contact Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto. (Subsidiary of Rockwell Manufacturing Company)

REPUBLIC INSTRUMENTS AND CONTROLS

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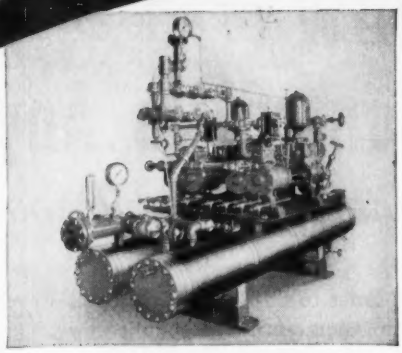
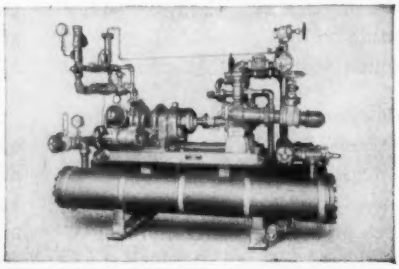
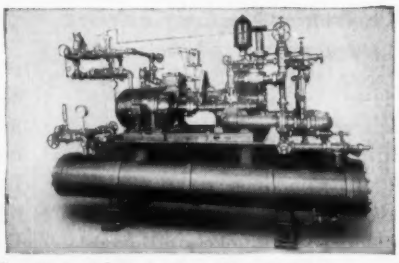


Two Horizontal Duplex Piston Type Steam Pumps and two fuel oil heaters—capacity 15 G. P. M. at 250 lb. pressure with either pump or heater.



One Turbine and One Motor Driven Pump and two fuel oil heaters. Capacity 30 G. P. M. at 150 lb. pressure with either pump or heater.



One Horizontal Duplex Piston Type Steam Pump and one Motor Driven Pump and two fuel oil heaters. Capacity 20 G. P. M. at 300 lb. pressure with either pump or heater.

Every detail part of an Enco Automatic Oil-Heating-and-Pumping Unit System is designed, assembled, checked and tested to make sure that it functions as an element of a completely coordinated unit. The sizes of pipes, fittings, valves and other elements are correctly proportioned for the efficient, dependable operation of the unit as a whole. All hand controls are visible and within reach of the operator for quick starting, stopping or cross-over reconnections between duplicate heaters and pumps. Adjustments and cleaning are similarly simplified.

Single or duplicate heaters and electric or steam-driven pumps are used. Interconnected duplicate units give full capacity with either pump or either heater. Capacities range from 100 to 5000 G. P. H. of heavy bunker oil.

BULLETINS ON REQUEST

OB-53 On oil burning, pumping and heating equipment.

OB-38 Instruction book on care and operation of oil-burner installations.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK 6, N. Y.

## Reports from the field

Begins on page 170

tury, according to a U of Michigan social scientist interested in historical cycles.

S S West, PhD, has studied figures dating back to 600 BC. Peaks occur every 164 years, he says, with low points coming in the intervals. According to his figures, next crest will be due in 1973, with a "major minimum" coming about 2055. Statistical analysis of membership trends in the American Physical Society bears him out: fastest growth is expected around 1973. And population forecasts indicate stability for mid-21st Century. West believes that population growth rates affect creative activity—a dynamic society creates, a stable society is relatively uncreative.

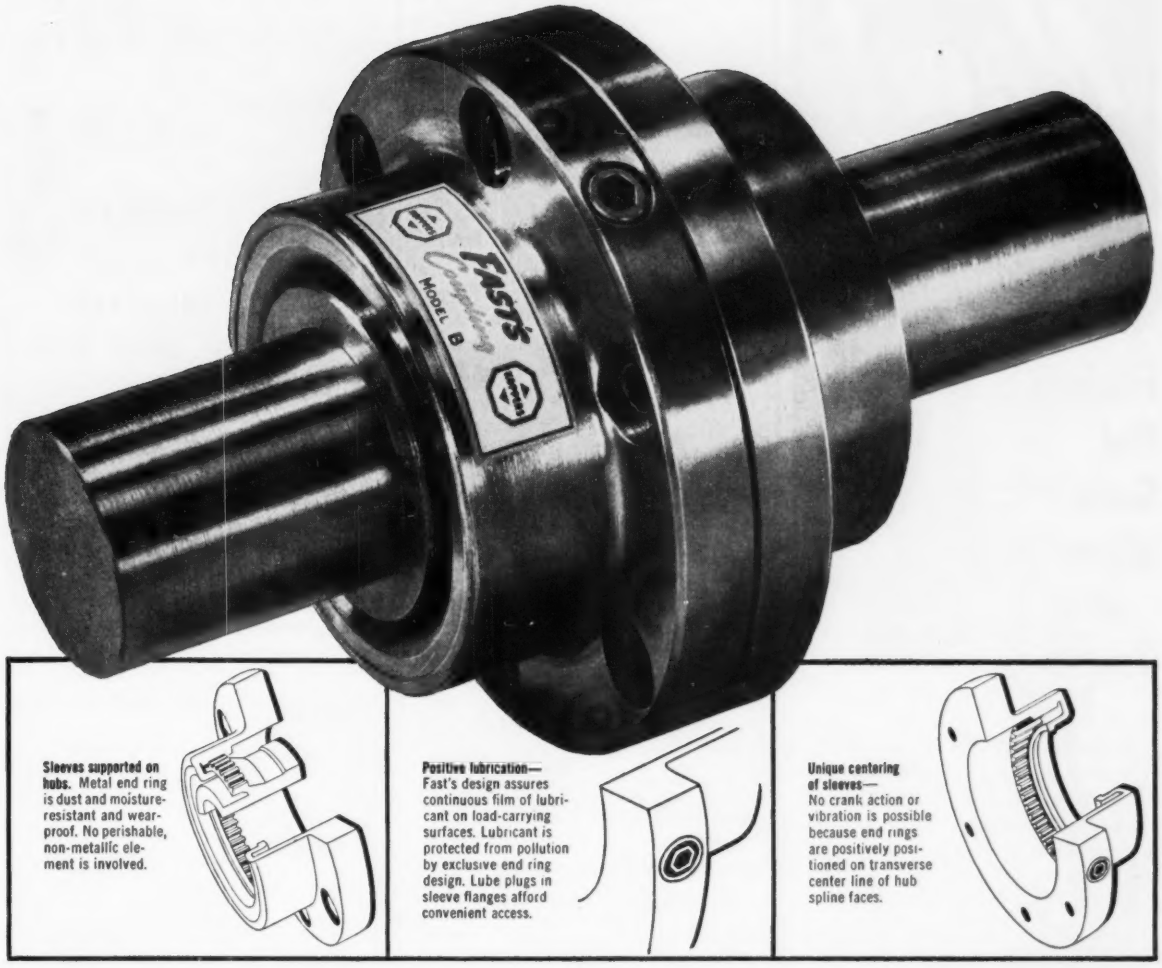
### New York Power Engineers to convene in Bronxville

Convention, exhibit and power show of the New York State Association of the National Association of Power Engineers, Inc, will take place May 7, 8 and 9th at the Hotel Gramatan, Bronxville, N. Y.

The NAPE was established in 1882, as a society of men supervising or operating power plants. Details on convention and show can be obtained from A J Miller, general chairman, Box 321, New Rochelle, N. Y.

### Scale model spots problems for low-cost nuclear plant

Space is tight in the Yankee Atomic Electric nuclear power plant, being built by Stone & Webster Engineering Corporation at Rowe, Mass., because




**Sleeves supported on hubs.** Metal end ring is dust and moisture-resistant and wear-proof. No perishable, non-metallic element is involved.



**Positive lubrication—** Fast's design assures continuous film of lubricant on load-carrying surfaces. Lubricant is protected from pollution by exclusive end ring design. Lube plugs in sleeve flanges afford convenient access.



**Unique centering of sleeves—** No crank action or vibration is possible because end rings are positively positioned on transverse center line of hub spline faces.



# Fast's Model B coupling reduces downtime and upkeep for light-to-medium drives

Mechanical flexibility eliminates costly shutdowns and expensive shaft replacements. But—it's only one of many cost-saving features.

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 5304 Scott Street, Baltimore 3, Md.

*Engineered* Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings



For more facts circle 322 on Reader Service Card, p 117

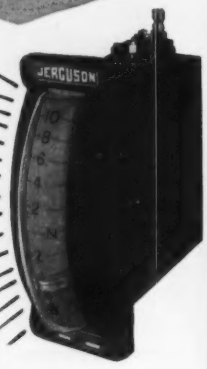
Here's Jerguson's

New!

RED FLASHER TRUSCALE

Remote Reading Liquid Level Gage

Flashing Red Scale Warns of Danger




Jerguson Truscales are now available with a unique new safety feature. Illuminated scale starts flashing red if boiler water level gets too high or too low. This positive warning flashes continuously until the dangerous condition is corrected.

Truscales offer the greatest possible protection for expensive equipment. They give instant remote reading of liquid level of boilers, tanks, etc., with the amazing accuracy of ½ of 1% of scale reading. Convex face, with scale markings directly on it, gives 180° visibility. It's easy to take readings from any point from which the face can be seen.

*Protect valuable equipment with Jerguson Truscale Remote Reading Gages. Send for new 8-page bulletin which gives complete details.*

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

100 Adams Street, Burlington, Mass.

Offices in Major Cities

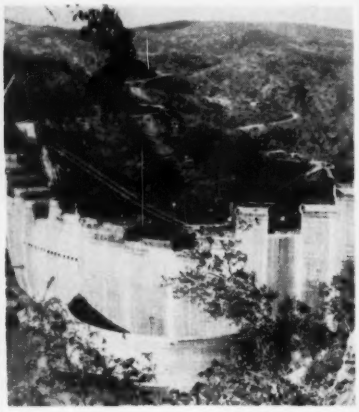
Bailey Meters & Controls, Ltd., London, Eng.
Controle Bailey, Paris, France

## Reports from the field

Begins on page 170

design specifies the lowest possible initial investment. This means that many space headaches encountered in ship design are also found here.

Model helps solve problems of piping flexibility, drainage, shielding, manpower access, accessibility of valves. It also helps coordinate mechanical engineering and structural design work. Shown in model is a primary loop with steam generator, pump and piping and regenerative heat exchangers for feed and bleed.



### Lions forced to relocate as 2000-sq-mi lake forms

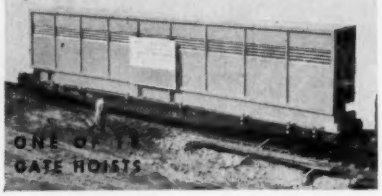
Farmers, tribes and wild animals have already been resettled, to make room for Kariba Dam and lake on the River Zambesi, Rhodesia. By 1960 the dam will be producing electricity, marking completion of the first phase of a $316 million project to supply power to Rhodesia's copper belt.

Behind the dam a 2000-sq-mi lake will form during the next two years. Bottom of the lake-to-be has already been smoothed to facilitate growth of a local fishing industry.

### Mammoth steam generator can hold a railroad car

When the Thos H Allen Electric Generating Station in Memphis, Tenn. was built, each of the three 2,000,000 lb per hr boilers acted as its own railway depot. Each steam generator has a 1300-sq-ft foundation. A spur was built from plant-site railroad siding onto temporary trestles across the foundations. After the main shell was

Murco GATE HOISTS

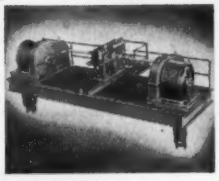


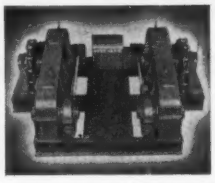

. . .TO CONTROL WATER LEVEL at LONG SAULT DAM, ST. LAWRENCE PROJECT

Each hoist weighs 93,000 lbs., shipped completely equipped with all electric motors, controls, limit switches, wired ready for operation . . . the overall length of one unit is 57 feet, 8½ feet wide, 12½ feet high . . . with a lifting capacity of 175 tons . . . will raise and lower the gates in the dam at a speed of 1 foot per minute.

MURCO GATE HOISTS . . . FOR ANY SIZE POWER DAM

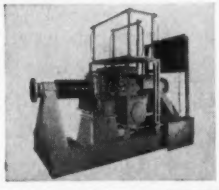
Capacities from less than 1 ton to over 100 tons.





From the smallest hand operated to the largest motor operated Gate Hoist.

Backed by over 75 years experience in design and manufacture.



Write for complete information and Engineering Department recommendations.

D. J. MURRAY MANUFACTURING CO.

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circle 323 on Reader Service Card, p 117

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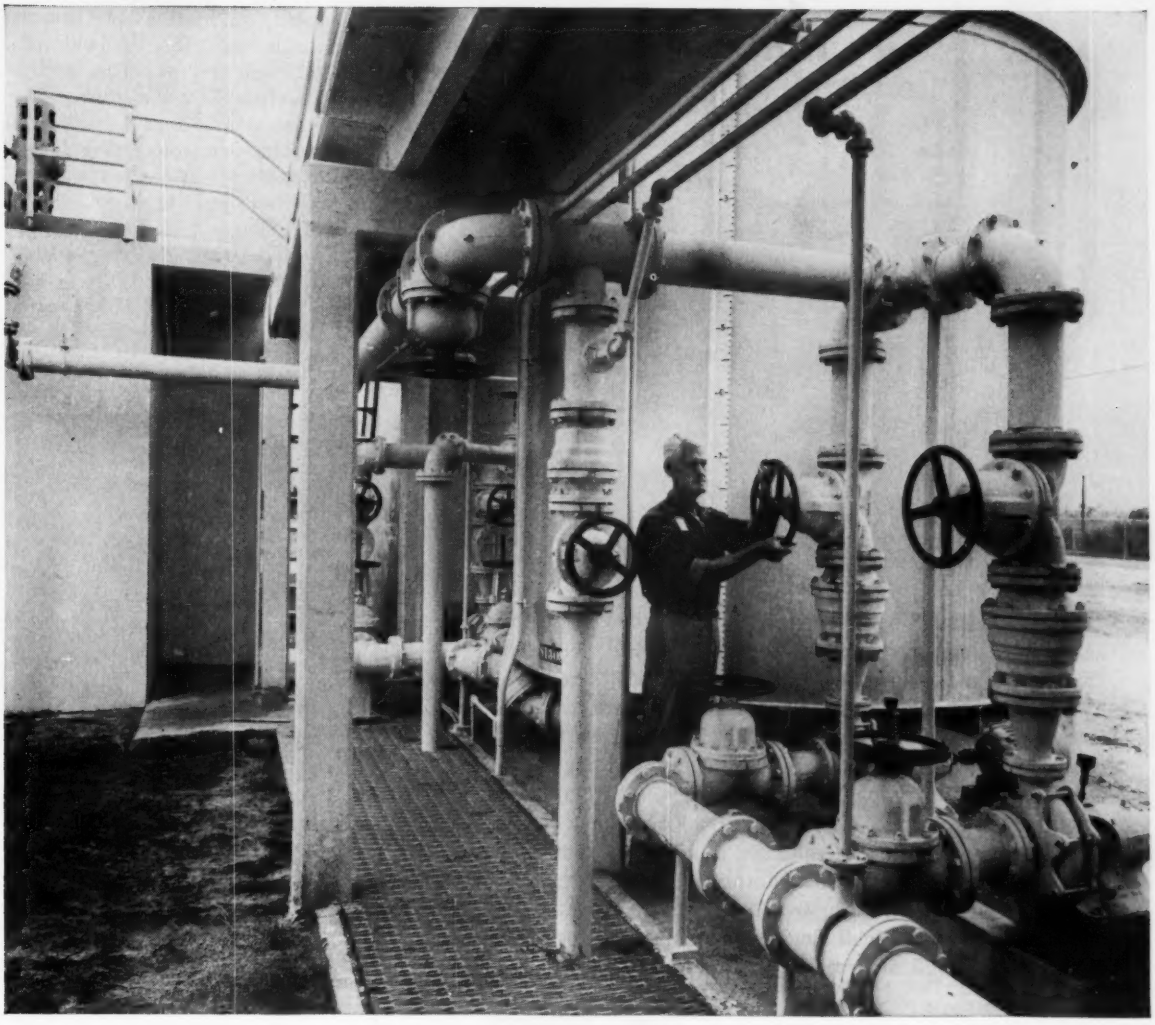
DOW | **SARAN LINED PIPE**



## After 9,000,000 gallons of heated acids, plating waste ... No Corrosion in **SARAN LINED PIPE**

When piping and valves carry more than a million gallons a month of heated acid and plating waste solution . . . when failure in the line would peril essential plant operations . . . there can be no guessing about corrosion resistance. The situation calls for Saran Lined Pipe and valves!

Shown above is one of the Saran Lined Pipe installations in use at the Florida R & D Center, Pratt & Whitney Aircraft, Division of United Aircraft Corporation, United, Florida. This installation carries 1,100,000 gallons per month of solutions of chromic acid, hydrogen fluoride, potassium cyanide, nitric acid, phosphoric acid and other chemicals. The solutions are in transfer from the Plating Department to waste treatment areas, at an average temperature of 100°F.

The Saran Lined Pipe and valves were installed eight months ago. Thanks to the extreme corrosion resistance and high mechanical strength of the piping, there's not been a single trace of corrosion or of failure.

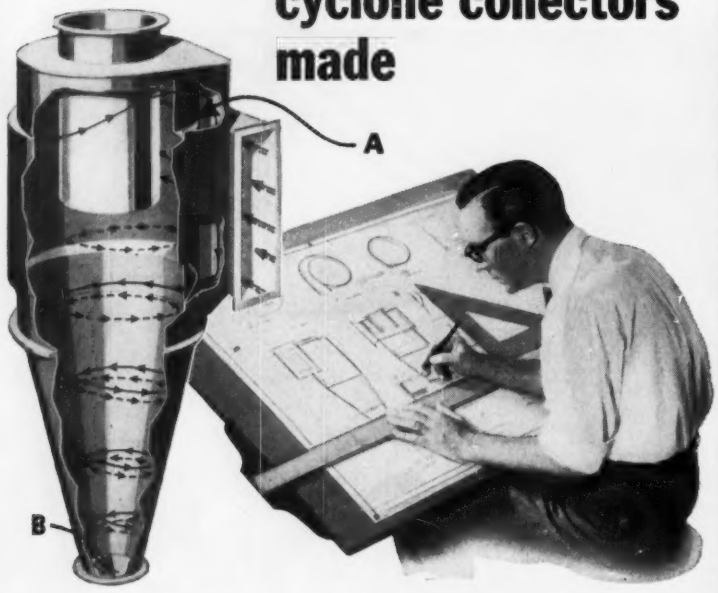
Whenever problems of corrosion and chemical activity are encountered in piping systems, Saran Lined Pipe is your best answer. Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200°F. They can be cut, fitted and modified in the field. For information, write Saran Lined Pipe Company, 2415 Burdette Ave., Ferndale, Michigan, Dept. 2289DW4.

**THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN**



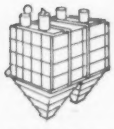
For more facts circle 325 on Reader Service Card, p 117

# The most efficient operating cyclone collectors made



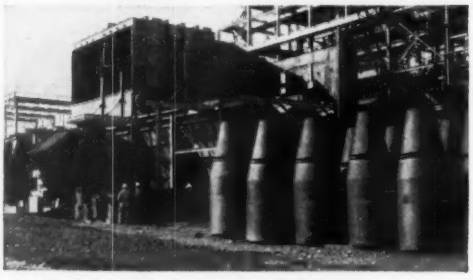

**Design makes the difference:** in over a thousand plants across the continent, Buell Cyclones have *proved* themselves more efficient than any other cyclones made. Buell's exclusive Shave-off port (A), traps the extra percentage of dust that ordinary cyclones lose. And large-diameter (B), custom-engineered design eliminates bridging, clogging, or plugging during operation, keeps efficiency high without interruption. Regardless of your present or planned plant layout, Buell equipment can be designed to solve your dust collection problems efficiently and economically. There's valuable information in a concise booklet, "The Exclusive Buell Cyclone". Write Dept. 50-D, Buell Engineering Company, Inc., 123 William Street, New York 38, N. Y.

BUELL CYCLONES



"SF" ELECTRIC PRECIPITATORS

PRECIPITATOR-CYCLONE COMBINATIONS



Buell Cyclones before installation at a major plant.

buell®

*Experts at delivering Extra Efficiency in*

**DUST COLLECTION SYSTEMS**

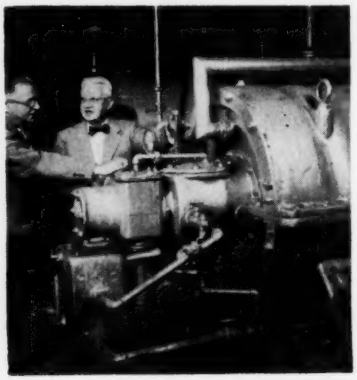

## Reports from the field

*Begins on page 170*

completed, heavy internal components were hauled right into the boiler, direct to where they would be used.

Boilers are 20 stories high. They supply steam at 2475 psig, 1053/1053 F to turbine-generators, using 2,000,000 lb steam per hr at a net heat rate of 8860 Btu per kwhr.

Station has a total nameplate capacity of 750,000 kw, a gross capability of 862,500 kw. It is the largest steam power plant ever authorized at one time by any municipality in the world.



### Centrifugal cooler retires after 36-year tour of duty

World's first centrifugal refrigerating machine, the first practical device for obtaining large quantities of cooling, has been on the line for 36 years at a New York State lithography shop. Carrier Corporation, builders of the original machine, have since turned out 4000 successors.

Developed in 1912 by the late Dr W H Carrier, the centrifugal first permitted use of completely safe refrigerant gas—nontoxic, noncombustible, operating at atmospheric pressure. This machine pointed the way to air conditioning for comfort, a concept which accounts for three-quarters of all air conditioning now in use.

### H-v aluminum cable saves time for missile plant

One of the largest installations of high-voltage aluminum cable in western industry provides feeder circuits for a 12-kv ungrounded neutral system at the U.S. Naval Industrial Re-

# CITY OF MANITOWOC INSTALLS SIXTH WICKES BOILER

R. E. Cannard—Chief Engineer and General Manager

Manitowoc Public Utilities Commission has just installed the sixth Wickes Steam Generator to help provide power for the City of Manitowoc, Wisconsin, and its surrounding area. The continued selection of Wickes equipment by this progressive municipality is a tribute to the dependability and quality of Wickes Steam Generators.

Wickes Boiler Co. builds steam generators for all branches of industry . . . for municipalities and for private and public buildings. Wickes units are available in sizes up to 500,000 lbs. of steam per hour and are designed for high or low steam pressures and temperatures, and for all types of fuels and firing methods. There is a Wickes design available for your needs.

Write for bulletin 55-1, showing the wide variety of designs and sizes available in both field-erected and shop-assembled* steam generators, or ask the nearest Wickes representative to call on you for full information.

*For the latest developments in shop-assembled boilers, investigate Wickes natural circulation A-type water tube units now built for capacities up to 75,000 lbs. per hour for oil and gas fuels. Request bulletins 56-1 and 57-1 for full information.

170

**WICKES**

**WICKES BOILER CO., SAGINAW 10, MICHIGAN**
**DIVISION OF THE WICKES CORPORATION**
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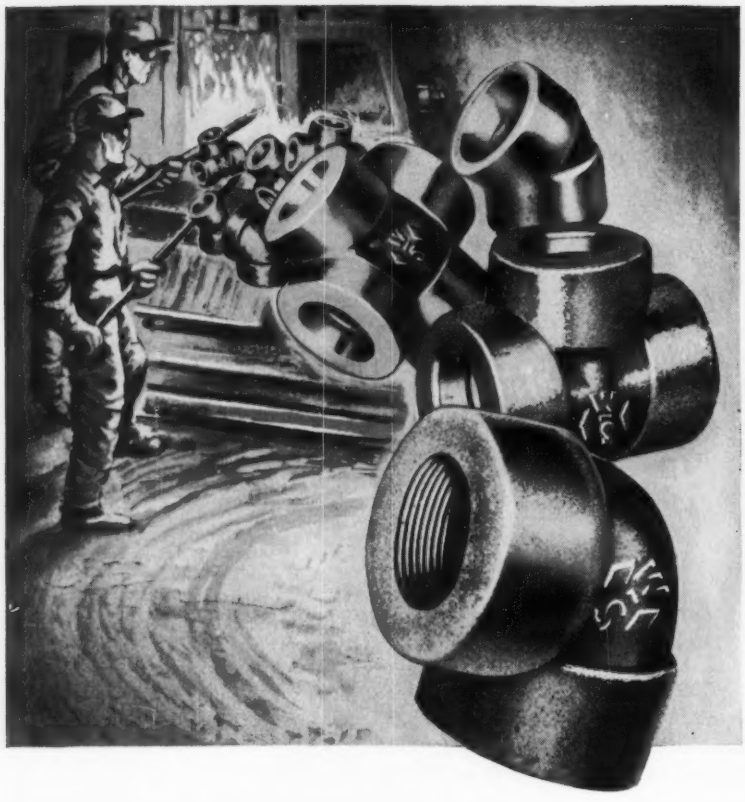
# Drop Forged from Solid Billets...

# FORGED STEEL FITTINGS



Heat . . . pressure . . . turbulence . . . oxidation . . . vibration . . . reduction . . . shock. For critical installation problems like these, get maximum protection with W-S Carbon, Stainless and Alloy Steel Fittings.

- Drop forged to produce exceptionally high tensile and impact strength.
- Long accurate threads, in perfect alignment, for ease of installation.
- Heavy uniform fitting wall thickness—an important safety factor.
- Accurate machining to fit tight.

For your next order, call your nearby W-S Distributor. You'll find him ready with comprehensive stocks of the complete line of W-S high-quality fittings. *Forge & Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, New Jersey.*

FORGE AND PORTER FITTINGS DIVISION

H.K. PORTER COMPANY, INC.

**Divisions:** Connors Steel, Delta-Star Electric, Disston, Forge & Fittings, Leschen Wire Rope, Mouldings, National Electric, Refractories, Riverside-Alloy Metal, Thermoid, Vulcan-Kidd Steel, H. K. Porter Company (Canada) Ltd.


## Reports from the field

Begins on page 170

serve Ordnance plant in California. Over 26,500 ft of 500-mcm aluminum power cable, butyl insulated, aluminum shielded and neoprene sheathed, was used in the circuits. Main feeder is 750-mcm aluminum conductor. Dc high-voltage insulation tests show very low leakage of .06 microamp at 40 kv.

Cable is 50% lighter, which saved 10 to 15% in installation man-hours —small fork lifts were used for moving the 60-in. spools. Kaiser Aluminum & Chemical Corporation made the cable.

### Refrigerated propane storage aids peak-shaving activities

When Atlanta Gas Light Company needed to extend its propane peak-shaving facilities, they decided on refrigerated storage to liquify the gas, save high equipment costs involved in pressure shortage.

Tank costs were cut one-third, but insulation became a problem. Insulation could not be attached directly because when tank went into operation at –46 F, contraction would pull walls away from the insulation.

Designers decided on *Foamglas*, a cellular-glass insulation made by Pittsburgh Corning Corporation. A free-standing wall of glass blocks was built around the tanks, not touching them. Wall is two layers of 4- and 3-in. blocks. Worker, above, applies second layer to roof.

Initial tank has been in service for two years, and two similar tanks were completed last fall. Each tank holds 1,297,500 gal of propane.

*(Advertisement)*

# HAGAN NEWSLETTER

# Behind the Panel

## AIR LIFT IN A BLAST FURNACE?

The 80,000 cfm or so of air supplied to a blast furnace has two functions: it provides combustion air, and it must also partially support the "burden," the mixture of coke, ore and limestone that is being reduced to pig iron. Blast air enters the furnace through a series of nozzles (tuyeres) arranged around the outside of the furnace. Flow through the nozzles is not normally under control. They are simply left wide open. Uneven distribution of air-flow through the tuyeres and upward through the burden can occur and this may result in refractory damage and "rough" furnace operation. Hagan automatic tuyere flow proportioning control systems lick this problem by metering equal amounts of air to each nozzle. The nozzle with the greatest back pressure is opened wide, and each of the others regulated in accordance with the set point. In this way, optimum furnace conditions are maintained with minimum pressure loss. At a recent installation, operators were skeptical, but after a week's trial run on full automatic, they changed their minds and now insist that the furnace be left on automatic at all times. (Item D-1)

## FLEXIBILITY--FIRST IN PRINCIPLE, THEN IN PRACTICE

In principle, torque suppression calls for torque in the opposite direction. Because the Hagan Ring Balance instrument operates on the torque established by different pressures, suppression is achieved by simply adding a weight to the ring, instead of changing range tubes as required by manometric instruments. For example, a Ring Balance instrument set to measure as much as 140 inches of level can be easily suppressed to measure a 20 inch full scale linear change anywhere within the 140 inch level. This flexibility of the instrument allowed a field expedient when there was an oxygen flow problem at a steel mill. A Ring Balance instrument measuring oxygen flow to the open hearth furnaces was installed in such a way that when the scarfing mill, which was ahead of the meter, used oxygen, the demand was so great that the flow past the meter reversed itself, flowing towards the scarfing mill. This reversal was doubted by plant personnel, so the Hagan engineer simply added a weight to the ring so that zero flow was registered at mid-chart. Sure enough, the next time oxygen was used by the scarfing mill, the meter registered the predicted reverse flow. (Item D-2)

## TOTALIZING RELAYS--SIMPLE WAY TO ADD MULTIPLE FLOWS

An industrial plant with a total of eight boilers wanted to determine the output of each boiler, and also to chart the total amount of steam produced. Steam is produced at 415 psig and 650 F, and the eight boilers generate approximately 800,000 lbs/hr. maximum. Ring Balance meters with pneumatic transmitters are used on all boilers, and on six of them the steam flow signal is also used for feedwater control. The output of the pneumatic transmitters is fed to a steam flow totalizing relay network consisting of seven Hagan Ratio Totalizers. The output of this network is then recorded on a total plant steam flow receiver recorder. Spot checks by plant personnel over the two years the system has been in operation show that the total of the individual boiler meters comes within 1% of the grand total shown by the total plant steam flow recorder. (Item D-3)

## HOW TO COLLECT SOYBEAN DUST

A Hagan Aerostatic Dust Collector is proving very successful in an unusual application for mechanical collectors. Soybean dust containing 44% soy meal with a minimum of 13% moisture is being collected at the rate of 1½ tons a day. On days of high humidity, the moisture content skyrockets, and an ordinary mechanical collector would have real plugging problems. However, the Hagan unit has been operating through periods of extremely high humidity, and has shown no sign of plugging. This is because the honeycomb design of the inlet area allows the inlets to nest closely together so that only sloping surfaces are presented to the dust stream. The plant is saving money on maintenance costs, too. The bag-type collector previously used cost $4-5,000 a year to maintain—while the Hagan unit has required no maintenance at all. (Item D-4)

## HAGAN CHEMICALS & CONTROLS, INC.

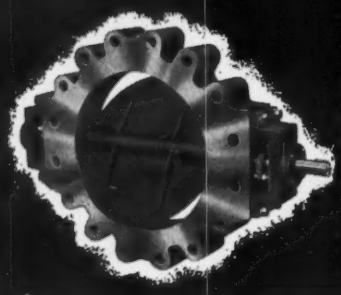
Hagan Building, Room 703, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

If you would like more information on any of the above items, check the appropriate box below.

☐ Item D-1 ☐ Item D-2 ☐ Item D-3 ☐ Item D-4


For more facts circle 329 on Reader Service Card, p 117

HOW MANY WAYS CAN A
BUTTERFLY VALVE
SERVE YOU?



The application of Fisher-Continental Butterfly Valves is virtually limitless in the gas, vapor, liquid or semi-solid flow control industries. These compact, low cost controls fit the specifications of a vast majority of applications.

FISHER-CONTINENTAL GIVES YOU FULL FREEDOM OF CHOICE

For gas, vapor, liquid or semi-solid control problems specify Fisher-Continental Butterfly Valves—any size . . . any metal or alloy . . . any temperature . . . any fluid . . . any pressure . . . any condition . . . any operator, manual or power.

*For complete details about Fisher-Continental Butterfly Valves send for free literature.*

FISHER GOVERNOR COMPANY
Marshalltown, Iowa/Woodstock, Ontario/London, England
*Direct Inquiries To:*
CONTINENTAL EQUIPMENT CO. DIVISION, CORAOPOLIS, PENNSYLVANIA

FISHER Controls
SINCE 1880

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MOST MAJOR U.S. POWER PRODUCERS REDUCE COSTS with PANALARM ANNUNCIATORS

MAXIMUM INFORMATION on all process variables . . . the result of 10 years system engineering by Panalarm and major power producers. That's why Universal Series 50 is the power industry's most informative annunciator. Trouble anywhere is signalled instantly—*before* it can grow big and expensive. "Off-normals" are pinpointed instantly, accurately for fast remedial action, reducing costly "outage" losses.

Economical, highly flexible design facilitates system expansion. Can be simply adapted to your exact requirement, avoiding costly custom designing. Proven components—e. g., almost 1,000,000 dependable Panalarm developed relays have been used in Panalarm Annunciators.

Ask your nearby Panalarm sales engineer to show you why Universal Series 50 is the power industry's No. 1 annunciator choice . . . how its adaptability and reliability can help increase your profits . . . by producing maximum information and reducing costly "outages." No obligation, of course.

*Write for Catalog 100 B today.*

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PANELLIT, INC.
7401 No. Hamlin Ave., Skokie, Ill.

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# Appointments

## Corporation changes

**Dominion Bridge Company, Ltd:** New regional method of operational control, with P E Savage, vice-president, Eastern Region; Mackenzie McMurray, vice-president, Ontario Region; E A Ford, vice-president, Central Region; R J A Fricker, vice-president, Western Region; R S Eadie, director of engineering; G H Midgley, vice-president.

**Allis-Chalmers Manufacturing Company:** B E Smith, vice-president. **Research-Cottrell, Inc:** L M Roberts, senior vice-president. **Ohio Brass Company:** J T Lusignan, vice-president of engineering; L J Ott, vice-president; E C Thompson, vice-president of manufacturing.

**General Electric Company:** F K McCune, vice-president in charge of atomic business development in marketing. **The Swartwout Company:** G V Patterson, vice-president.

## Operations changes

**Allis - Chalmers Manufacturing Company,** Atomic Energy Div, Nuclear Power Dept: C R Braun, manager. **The Martin Company,** Nuclear Div: Dr C P Stanford, chief of engineering dept.

**General Electric Company:** B H Caldwell, general manager of Knolls Atomic Power Laboratory. **I-T-E Circuit Breaker Company,** Bull Dog Electric Products Div: H C Egerton, general manager.

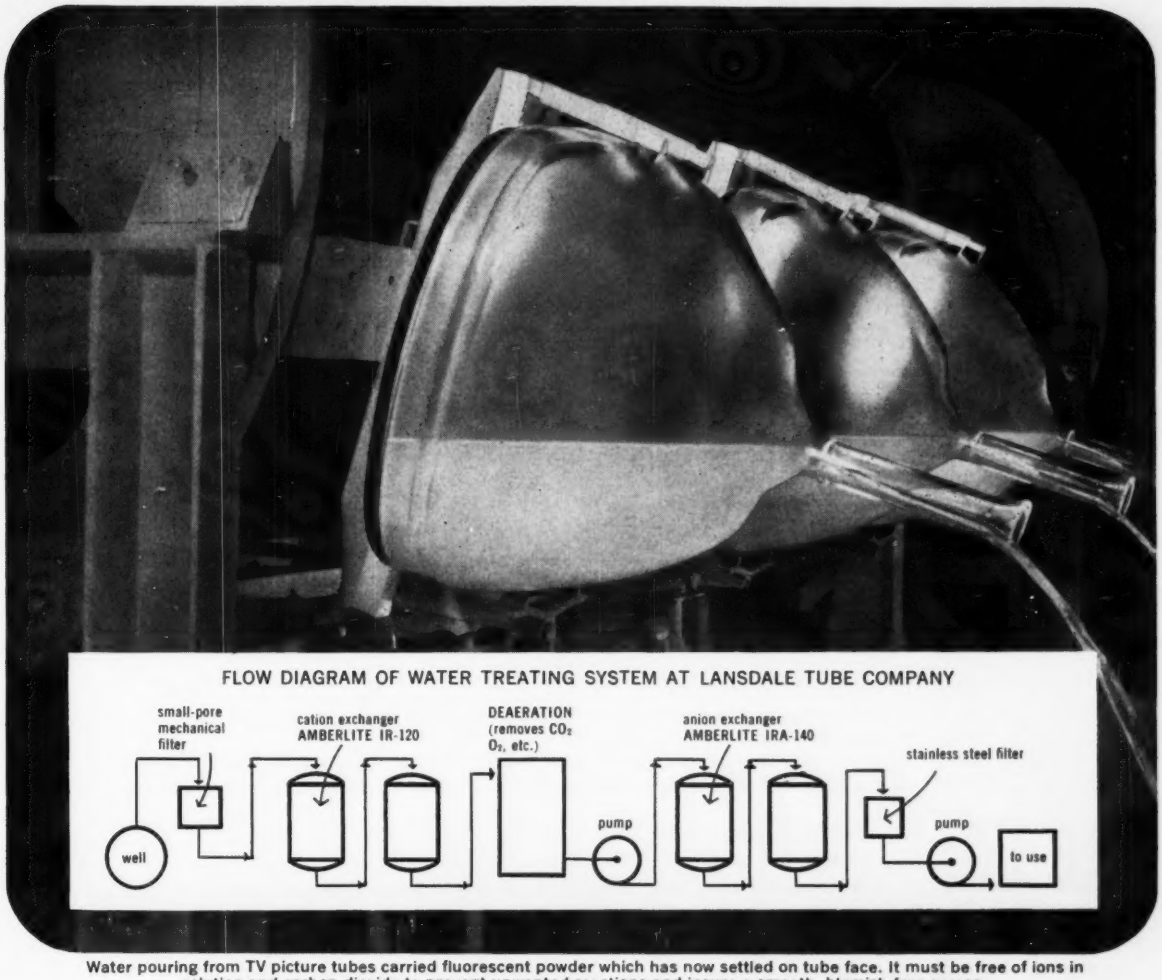
**Marion Electrical Instrument Company:** C A Anderson, general manager. **Dresser Industries, Inc,** Roots-Connersville Blower Div: D M McDowell, director of engineering. **Stevens Institute of Technology,** Experimental Towing Tank laboratory: Dr J P Breslin, director.

**Cochrane Corporation:** G E Glover, manager of industrial-waste dept. **Whitehead Metals, Inc:** G L Cox, technical manager.

**Hoskins Manufacturing Co:** N F Spooner, manager of research and development. **Century Electric Company:** L C Schaefer, manager of engineering. **Cook Electric Company,** Cook Research Laboratories Div: A D Anderson, R O Fredette, associate directors.

continued

**ION EXCHANGE RESINS** pave the way for perfect TV pictures



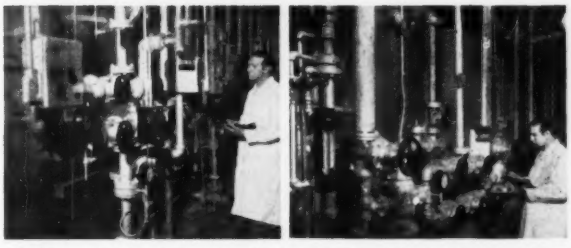

Water pouring from TV picture tubes carried fluorescent powder which has now settled on tube face. It must be free of ions in solution and carbon dioxide to prevent unwanted reactions and insure a smooth, blemish-free screen.

# TV needs 100,000 gallons of AMBERLITE-treated water every day, at Philco's Lansdale Tube Co. Division

Plating perfect fluorescent screens on the inside of those big picture tubes calls for water completely free of metallic impurities and carbon dioxide—for washing tubes and preparing phosphor solutions. At Philco's Lansdale Tube Co. Division, the water treating system teams AMBERLITE IR-120 cation exchange resin and AMBERLITE IRA-410 anion exchange resin to provide water free of troublesome ions.

Water from the company's well contains 180 ppm hardness, 240 ppm dissolved solids, 150 ppm alkalinity. After treatment, deionized and filtered water shows over 600,000 ohm electrical resistance at 18°C., twice the required minimum for picture tube use. Water of 20,000,000 ohm resistivity at 18°C. for the manufacture of electronic components is obtained by passing the deionized water through small MONOBED units containing a mixture of AMBERLITE IR-120 and AMBERLITE IRA-400. AMBERLITE-treated water replaced distilled water in all manufacturing processes at Lansdale Tube Co. in 1947.

Can ion exchange help you? Your engineering company, qualified by experience in water conditioning, can tell you how AMBERLITE ion exchange resins may solve your problem. Write today for a copy of "If You Use Water . . . " 24 pages of the latest information on water conditioning.



Cation and anion exchange units in operation at Lansdale Tube Co.

AMBERLITE *and* MONOBED *are trademarks, Reg. U.S. Pat. Off. and in principal foreign countries.*

*Chemicals for Industry*

**ROHM & HAAS COMPANY**

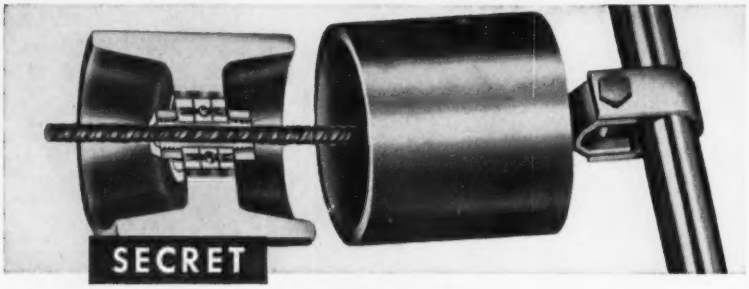
**THE RESINOUS PRODUCTS DIVISION**

**Washington Square, Philadelphia 5, Pa.**

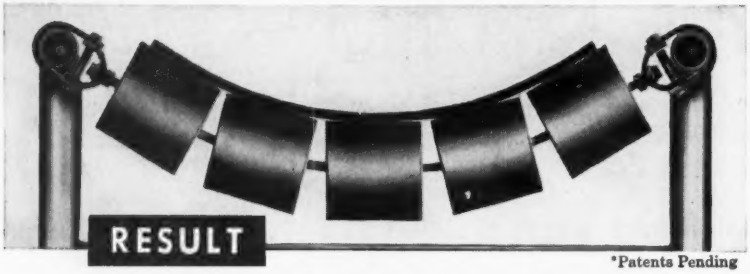


**For more facts circle 332 on Reader Service Card, p 117**

# NEW (EXCLUSIVE WITH McNALLY PITTSBURG) CONVEYOR DESIGN ... slashes maintenance cost! ... extends belt life!




. . . of the amazingly improved efficiency of this modern belt conveyor is shown here. This new McNally Pittsburg Cradle Idler* consists of 5″ rubber rollers assembled on precision ground ball bearings, prelubricated and lifetime sealed. Being a *true catenary* suspension with rollers mounted on flexible, *non-rotating* stainless steel wire rope, this design eliminates "loping" and dangerous harmonics.




*Patents Pending

. . . is greater capacity and faster belt operation with minimum spillage. Since the belt lies in true arc with no creases or bends to cause wear, *belt life is substantially increased.* Because this McNally Pittsburg conveyor design is so simple, costs are lower, and erection time is reduced.

WRITE TODAY | for details on the new conveyor which costs less to install . . . *saves money every day it is in use.*

**McNALLY · PITTSBURG**

McNally Pittsburg Mfg. Corp.
Dept. P
Pittsburg, Kansas

☐ Please send information on the new McNally Pittsburg belt conveyor.

☐ Have Sales Engineer call for further consultation.

Name_____ Title_____

Company_____

City_____ State_____


## Appointments

Begins on page 188

### New district offices

**Assembly Products, Inc:** at 309 Lindsay St, Ridley Park, Pa. **Oliver-Tyrone Corporation,** Berry Hydraulics Div: at Corinth, Miss. **B-I-F Industries, Inc:** at 256 Peachtree Blvd, Baton Rouge, La.

**S&C Electric Company:** Eastern Sales Div at 1180 Raymond Blvd, Newark 2, N. J.; G G Leu, manager. **Clark Controller Company:** at 18430 W Seven Mile Rd, Detroit 35, Mich.; J L Whitely, manager. **H K Porter Company, Inc,** Delta-Star Electric Div: at 3400 N Meridian St, Indianapolis 8, Ind.; R E Daub in charge.

**Fischer & Porter Co:** at Jacksonville, Fla.; Ben Volker, manager. **Lunkenheimer Co:** at 3711 Polk Ave, Houston, Texas; William Boles, branch manager.

### New names

**Allis - Chalmers Manufacturing Company:** Atomic Energy Div with overall responsibility for atomic work; Nuclear Power dept for activities in nuclear-fission field. **Air Reduction Sales Company:** new facility for production of oxygen and nitrogen, at 1100 Packard St, Kansas City, Kan.

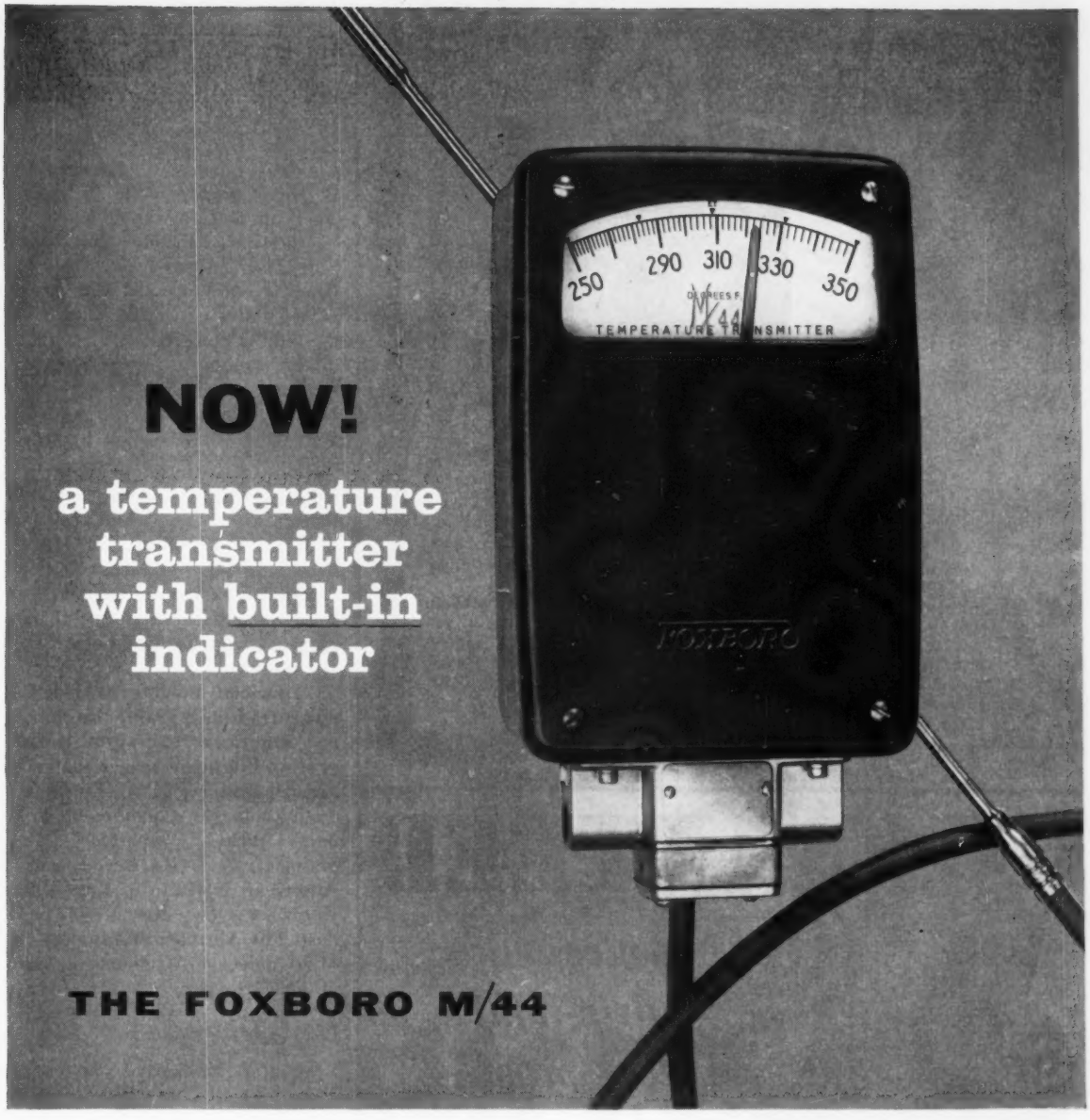
**Anderson Electric Corporation:** Special Products Div. **The Zero-Max Company:** new sales subsidiary of Revco Incorporated. **Ansul International Corporation, S. A.:** distribution of Ansul Chemical Company products to all countries outside the U.S.

### Recent purchases, mergers

**The Anaconda Co:** merger of American Aluminum Co and Cochran Foil Corp subsidiaries into Anaconda Aluminum Co, A P Cochran, president.

**The Green Fuel Economizer Co, Inc:** acquisition of Bayley Blower Company. **Infilco Incorporated:** acquisition of Gale Separator Co.

**Food Machinery and Chemical Corporation:** acquisition of business of J S Coffin Jr Co. **H K Porter Company, Inc:** acquisition of the




# NOW!

## a temperature transmitter with built-in indicator

**THE FOXBORO M/44**

Here's a brand new instrument engineered specifically for the job of indicating and transmitting temperature.

The new Foxboro M/44 *Indicating* Temperature Transmitter offers the inherent simplicity of a motion balance instrument. It works with any filled thermal system — transmits its output pressure to any remote 3-15 psi recorder, controller, or indicator.

The M/44's indicating scale and fluorescent red pointer are visible up to 20 feet away. And since the pointer is directly linked to the measuring element, the instrument continues to indicate process temperature even in event of an air supply failure.

The new M/44 is one of the many advanced Foxboro instruments for measurement and control of temperature from —450 to +2800. Others are listed at the right. Ask your Foxboro Field Engineer about any of them. Or write **The Foxboro Company, 684 Neponset Avenue, Foxboro, Massachusetts.**

**COMPLETE TEMPERATURE INSTRUMENTATION**

**PRIMARY ELEMENTS**
Complete selection for filled thermal systems, and for electric resistance bulb and thermocouple type systems

**TRANSMITTERS**
Foxboro motion balance type (shown above) for local indication and simplicity, or Type 12A force balance for maximum overrange protection.

**CONTROLLERS, INDICATORS, RECORDERS** } air, electric, and electronic operated

**FOXBORO**
REG. U.S. PAT. OFF.

**TEMPERATURE MEASUREMENT AND CONTROL**


For more facts circle 334 on Reader Service Card, p 117

# END VIBRATION DAMAGE

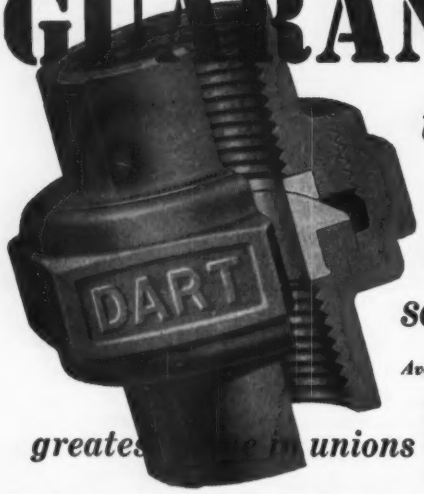
Robertshaw's Vibraswitch Malfunction Detector protects machinery from costly damage resulting from excessive vibration. Sensing instantly the beginning of destructive vibration caused by *failing bearings, bent shafts, broken blades* or *overspeeding,* Vibraswitch actuates an alarm or shuts down the malfunctioning equipment.

Available in various models, Vibraswitch may be easily installed on large motors, pumps, fans, compressors and other rotating or reciprocating machinery. Write for Technical Bulletin RF-586.

**Aeronautical and Instrument Division, Robertshaw-Fulton Controls Company, Santa Ana Freeway at Euclid Avenue, Anaheim, California.**

For more facts circle 335 on Reader Service Card, p 117

# GUARANTEED




*to give drip-tight leak-proof seal*

*Available through your local distributor*

*greates[illegible] in unions* **DART**

For over 55 years the firm guarantee back of each and every DART UNION sold has been — *"if one should leak through we will give you two"!* The record reveals that less than 1 in every 100,000 has proven to be faulty. The extra wide bronze to bronze seats, precision ground to a true ball joint, mounted in heavy malleable iron pipe ends and protected by an extra heavy union nut, make a drip-tight, leak-proof connection WITHOUT EXCESSIVE WRENCHING time and time again.

Guarantee positive tight connections and extra long service on your pipe lines by using the DART GUARANTEED UNION.

Yours on request: Descriptive brochure on Dart Unions and Union Fittings.

DART UNIONS
*Products of*
DART UNION COMPANY
PROVIDENCE, R. I.

GENERAL SALES AGENT

THE **Fairbanks** COMPANY
393 LAFAYETTE STREET, NEW YORK 3, NEW YORK
BRANCHES: NEW YORK 3
PITTSBURGH 22 • BOSTON 10 • ROME, GEORGIA


## Appointments

*Begins on page 188*

business of National Electric Products Corporation. **George Windeler Company, Ltd:** acquisition of Mechanical Draft Tower Div of G W Galloway Company. **Colorado Oil & Gas Corporation:** purchase of Jas P Marsh Corporation.

**National Electric Coil Company:** merged into a division of McGraw-Edison Company. **The Associated Valve Co** and **Marine & Industrial Products Co:** coordination of manufacturing and marketing facilities, relocation at N Wales, Pa.

### Institute elections

**National Association of Corrosion Engineers:** H P Godard, Aluminum Laboratories, Ltd, president; G E Best, Allied Chemical Corp, Solvay Process Div, vice-president.

**Engineers Joint Council:** E R Needles, re-elected president; Dr A B Kinzel, Union Carbide Corporation, vice-president.

**American Society of Heating and Air-Conditioning Engineers** and **American Society of Refrigerating Engineers:** consolidation as American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), with Cecil Boling, president; A J Hess, vice-president. **American Institute of Consulting Engineers:** G S Richardson, president. **The Aluminum Association:** M M Anderson, Aluminum Company of America, president.

### Obituaries

**Joseph E Kennedy,** 95, founder and chairman of the board of Kennedy Van Saun Mfg & Eng Corp, on January 9th.

**Ellis L Phillips,** 85, philanthropist and former president and board chairman of Long Island Lighting Company, on January 29th.

**John B Saxe,** 56, vice-president and chief consulting engineer of Gibbs & Hill, Inc, on February 15th.

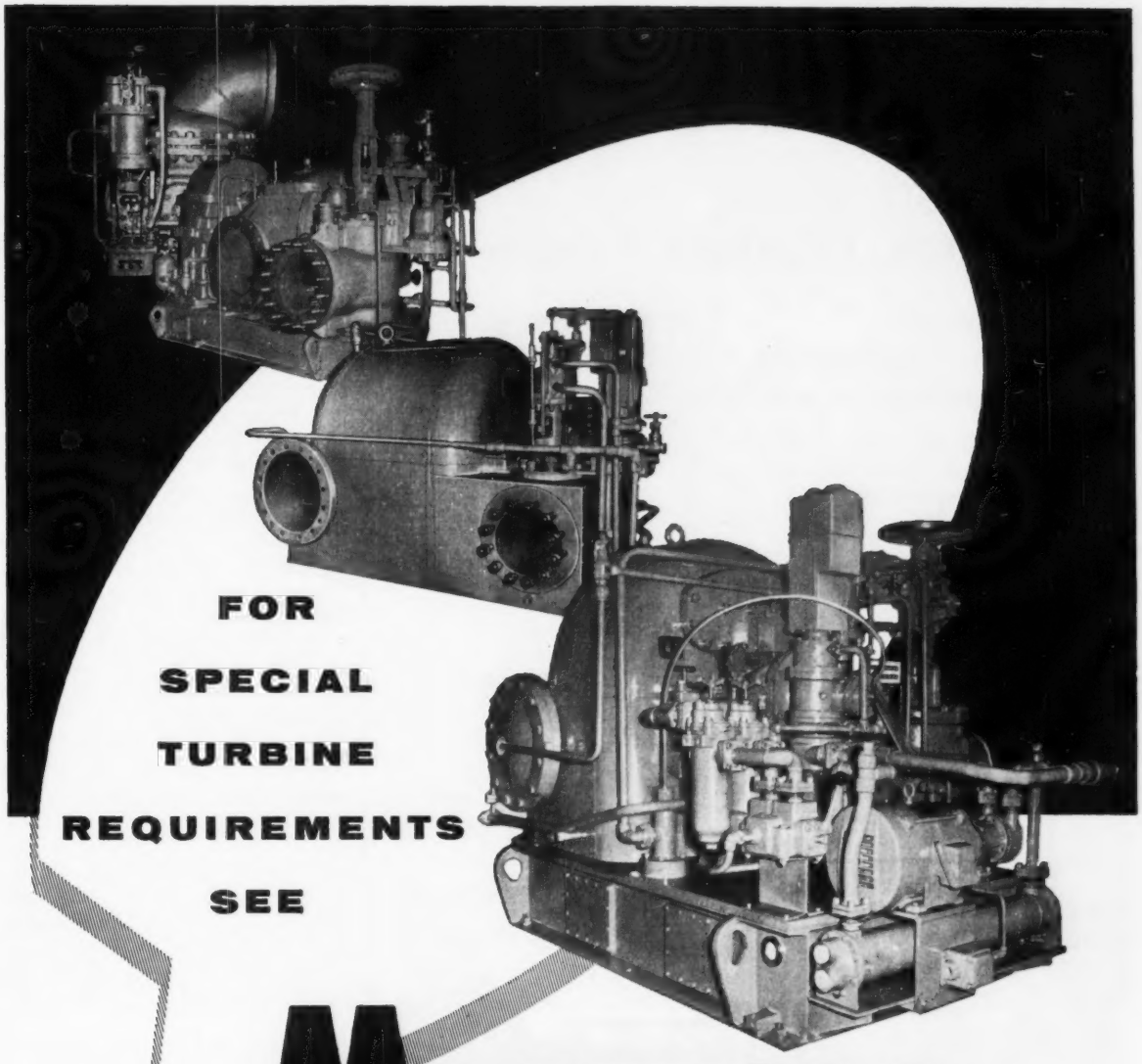
**Henry F Vogt,** 79, board member and former officer of Cutler-Hammer Inc, on February 16th.

**Timothy E Levene,** director of purchasing and production control for Curtis Manufacturing Company, on January 30th.

**Col Joseph J Ring,** 72, retired chief engineer of Allis-Chalmers Manufacturing Company hydraulic dept, on January 30th.



For more facts circle 336 on Reader Service Card, p 117



FOR SPECIAL TURBINE REQUIREMENTS SEE

# Murray TURBINES

- Low Inlet Pressures
- High Back Pressures
- High Speeds
- Variable Speed Ranges
- Precise Control
- Multi-Valve Designs
- Double End Gear Drives
- Vertical Shaft Turbines

*Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.*

**MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA**

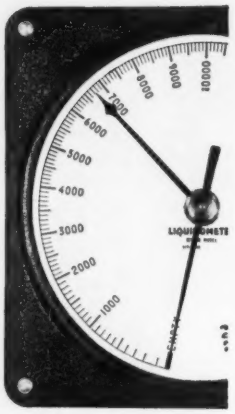
**Builders of Steam Power Equipment for Nearly a Century**



For more facts circle 337 on Reader Service Card, p 117

# DEPENDABLE
# 100% AUTOMATIC
## REMOTE READING
## Tank Contents Gauges

- RELIABLE
- NO POWER REQUIRED
- UNDERWRITERS' APPROVED



Liquidometers use a temperature compensated balanced hydraulic system. Indications unaffected by changes in specific gravity. All models feature large easy-to-read dials. UL approved switches available.

**Write for complete details to Dept. R.**

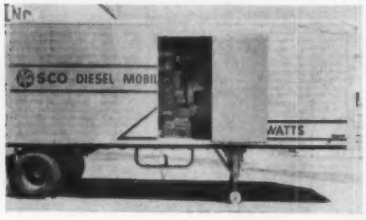
Since 1920 ...of proven quality

**THE LIQUIDOMETER CORP.**
LONG ISLAND CITY 1, NEW YORK

**For more facts circle 338 on Reader Service Card, p 117**

*(Advertisement)*

## Diesel-Electric power plant on wheels



Uninterrupted power under emergency conditions is now being assured throughout the state of Nebraska by operation of two power plants on wheels. Assembled as a full trailer unit, the plants are used during change-over of lines and sub-stations and during emergency weather conditions. Each unit contains a General Motors 450 hp model 8-268A diesel engine and a Westinghouse 300kw, 375kva electric generator complete with switchgear and radiator. 300 kw power plants on wheels, manufactured by A. G. Schoonmaker Company, are available for immediate delivery and arrive ready to operate on all power requirements.

**A. G. SCHOONMAKER COMPANY, INC.**
Foot of Spring Street, Sausalito, California
EDgewater 2-1490
50 Church Street, New York 7, N. Y.
Digby 9-4350

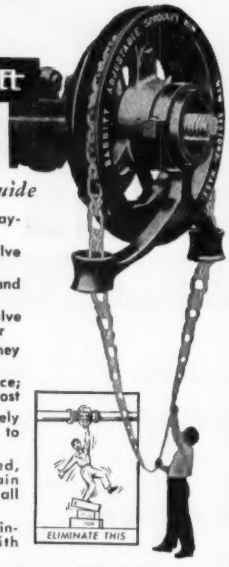
**circle 339 on Reader Service Card, p 117**

## Safe Operation of Overhead Valves

*with a*

**Babbitt**

*Adjustable*
**SPROCKET RIM**
*with Chain Guide*




- Simplifies pipe layout
- Fits any size valve wheel
- Easy to install and operate
- Operates any valve from plant floor
- Time and money saving fixture
- No maintenance; first cost only cost
- Packed, completely assembled, one to a carton
- Hot galvanized, rust-proof chain available for all sizes
- Easy to follow instructions with each unit
- Your supplier carries complete stocks
- Write for new descriptive catalog sheet and prices

**Babbitt STEAM SPECIALTY CO.**
2 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

**circle 340 on Reader Service Card, p 117**


# Bookshelf

**Air Conditioning and Refrigeration.** *By William H Stevens, late Prof of Mechanical Engineering, Purdue University, and Julian R Fellows, Prof of Mechanical Engineering, University of Illinois. 9x5¾, 563 pp, illust, $10.25. John Wiley & Sons, Inc, 440 4th Ave, New York, N. Y.*
Mechanical engineering and architectural undergraduates and home-studiers are the main audience for this book, written primarily as a text. The first third covers basic principles of the subject. This material is bulky, but makes a handy reference for later calculations.

Four chapters are then devoted to a discussion of heating equipment—furnaces, radiators, piping, insulation. This discussion gives the student background material which is helpful when he gets into steam and hot-water heating systems and their computations. This part ends with a discussion of radiant heating, which is comprehensive although not directly concerned with book's subject.

Student is then led through methods for sizing air-handling equipment (fans, ducting, cleaning devices), air heating and cooling machinery and principles, cooling-load calculations, and the controls necessary for air-conditioning systems.

**Transients in Electrical Circuits.** *By Gladwyn V Lago and Donald L Waidelich, Associate Prof and Prof at University of Missouri. 393 pp, 398 illust, $7.50. Ronald Press Co, 15 E 26th St, New York 10, N. Y.*
This book on electrical transients has been written for junior and senior electrical engineering students, but should be a good source of reference and review to practicing engineers. It assumes a knowledge of differential and integral calculus, and at least an introductory course in electrical-circuit theory. The classical methods of circuit solutions are treated before going into the Laplace transform method. Various methods of factoring high-degree polynomials are explained.

A number of applications are presented. One application is concerned with the steady-state response to non-sinusoidal wave shapes by use of recurrent transient methods. Another

ACCO
for Better
Values

THE COMPLETE LINE—

# R-P&C VALVES

DESIGNED FOR DEPENDABILITY

## This new FORGED STEEL GLOBE VALVE offers maximum strength and safety...longer life!

• R-P&C's new F80 Forged Steel Globe Valve is a versatile, precision-built addition to a distinguished valve family. Designed and engineered in cooperation with many of the country's leading engineers of the power, process piping and shipbuilding industries, the F80 Globe Valve is manufactured to the most rigid standards to overcome the problems of ever-increasing temperatures, pressures and corrosion.

Here are a few of its many features that insure greater strength and safety, longer service life and lower maintenance cost: Forged Steel body, bonnet and gland..."375 Brinell" stem with rolled stem threads..."500 Brinell" disc-lapped seat face...molded, reinforced asbestos packing. Test Pressures: Hydrostatic Shell test, 2500 P.S.I....Seat Test (air under water), 100 P.S.I....Pneumatic Testing at 300 P.S.I. when specified. For details, *write for Folder DH-213.*

### R-P&C offers a Complete Line

• Look to your R-P&C Distributor for R-P&C gate, globe, angle and check valves—in bronze, electric iron, cast or forged steel—in a wide range of styles, sizes and pressure classes. In addition, R-P&C offers a full line of cast steel fittings, also specialties such as asbestos-packed cocks, bar stock valves, Lubrotite gate valves and other items. For complete R-P&C catalog, write our Reading office.

BAR STOCK VALVE

BRONZE GATE VALVE

IRON GLOBE VALVE

**FREE WALL CHART**
*"How to Protect Your Valves"*
Installation pointers, operating tips, clues to longer valve life. They are all on this 22" x 17" wall chart. Write for your free copy.

**R-P&C VALVE DIVISION**
**AMERICAN CHAIN & CABLE**

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

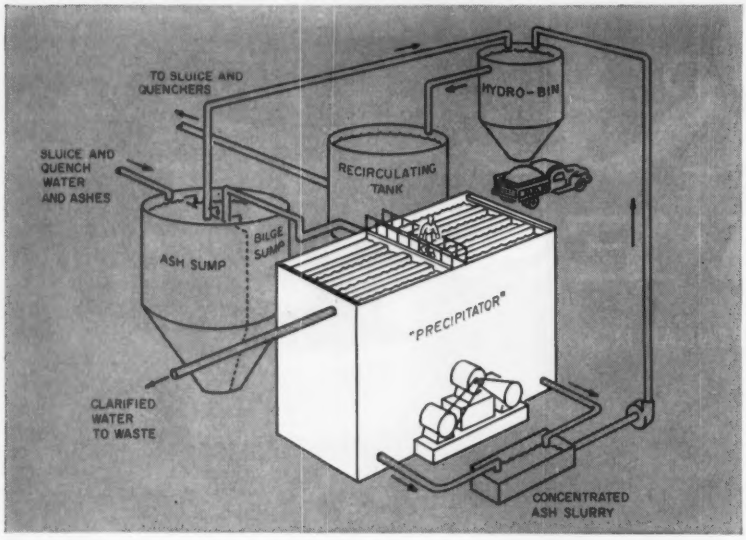
ACCO




For more facts circle 341 on Reader Service Card, p 117

# FLUIDICS

is a Pfaudler Permutit program providing
the know-how
the equipment
and the experience
for solving problems involving fluids




FLUIDICS AT WORK

## Precipitator separates 15 to 25 tons of ashes per day for U.S. Rubber Co.

. . . makes ash-handling system flexible, dependable.

Ash problems at U. S. Rubber's Detroit plant are typical. The powerhouse has widely varying loads . . . requiring a flexible ash-handling system. The system must also be dependable, because all clarified effluent water goes into the Detroit River and this water must not contain suspended solids that could obstruct the river channel.

Tests were run at U. S. Rubber's plant using a pilot-scale Permutit Precipitator. As a result of these tests, a 300 gpm horizontal unit was installed. (See simplified flow chart.)

U. S. Rubber's Permutit Precipitator goes a long way to make their system successful. In use over 2 years, the Precipitator handles varying loads of 15 to 25 tons of suspended ash per day . . . at low cost without coagulants or other chemicals . . . yet it always delivers effluent water as clean as the river water itself.

Pfaudler Permutit offers impartial advice about water treatment . . . based on experience with all basic types of solids separation processes—coagulation, settling, flotation, centrifuging, evaporation and ion exchange. Write to our Permutit Division, Industrial Waste Treatment Dept. PO-49, 50 West 44th St., New York 36, N.Y.

FLUIDICS covers such varied phases of fluid handling and control as:

| | |
|---|---|
| water treatment | metering |
| waste treatment | valving |
| corrosioneering | flow rate control |
| fluid analysis | piping |
| agitation | storing |
| blending | heat transfer |

Whenever you have a fluid-handling problem put the Pfaudler Permutit FLUIDICS program to work.

**PFAUDLER PERMUTIT INC.**

Specialists in FLUIDICS . . .
the science of fluid processes


## Bookshelf

Begins on page 194

application extends circuit-theory methods to mechanical and electromechanical systems. Electrical analogs of these systems are explained. However, no work on the solution of partial differential equations, such as those of transmission lines and field theory, has been included in the present volume.

**Thermodynamics,** *3rd edition. By Virgil M Faires, Professor of Mechanical Engineering, North Carolina State College. 543 pp, illust, tables, 6¼ x 9½, cloth, $7.50. The Macmillan Company, 60 Fifth Ave, New York 11, N. Y.*

**Elementary Thermodynamics,** *3rd edition. By Virgil M Faires, Professor of Mechanical Engineering, North Carolina State College. 379 pp, illust, tables, 6¼ x 9½, cloth, $6.75. The Macmillan Company, 60 Fifth Ave, New York 11, N. Y.*

These well-known books have now been revised for the third time. The first one is the complete treatment designed for a full year's study of the subject in engineering courses. The second book is largely an abstract of the first with the aim of serving as the text for short courses of study and shallower depth of content.

These editions have been fully rewritten with a more sophisticated treatment than in the earlier editions. The author continues his philosophy of showing how thermodynamic relations apply to practical apparatus. He gives the student an opportunity to learn how to apply each new principle by showing how it is applied in a numerical example.

The text includes a good introduction to the Keenan and Kaye Gas Tables, which like the Steam Tables lighten the load of mathematical work in solving problems. An expanded use of energy flow diagrams helps to clarify relations when dealing with energy apparatus.

In addition to covering the elementary relations the book also discusses the thermo of compression and expansion of gases, gas turbines, turbojets, i-c engines, gas mixtures, combustion, steam power plants, refrigeration, air conditioning and heat transfer.

# Operating efficiency goes **up** . . . costs **down** when Carpenter Stainless Condenser Tubing goes in

**PROVING GROUND**—Partial view of 40,000 sq. ft. main surface condenser where superiority of Carpenter Stainless Tubing has been demonstrated by extensive tests under actual operating conditions.

• Comparative tests under severe operating conditions prove Carpenter light-wall stainless tubing is a key to improved efficiency in power plant operation. Its superiority has been demonstrated in brackish, highly acid and other low ph circulating water conditions. In the main condenser of a large Eastern utility, exhaustive checking and re-checking of comparative performance over a 3-year span verifies these important advantages:

*longer tube life • greater resistance to erosion • more resistance to scale and corrosion • better heat transfer than published rates • greater and faster thru-put of cooling water • higher strength to weight ratio • improved tube cleanliness, less cleaning • lower tubing costs*

Data compiled from these extensive tests are available to your engineering staff as a help in solving your tubing problems in power plant equipment. Technical assistance in tube selection and installation is available through our nearest office. Or write to The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

*your master key to cost savings in power equipment*

Carpenter

**Stainless Tubing & Pipe**



**For more facts circle 343 on Reader Service Card, p 117**

# NOW ADDED TO LESLIE's COMPLETE LINE...

# TWO NEW CONCEPTS IN

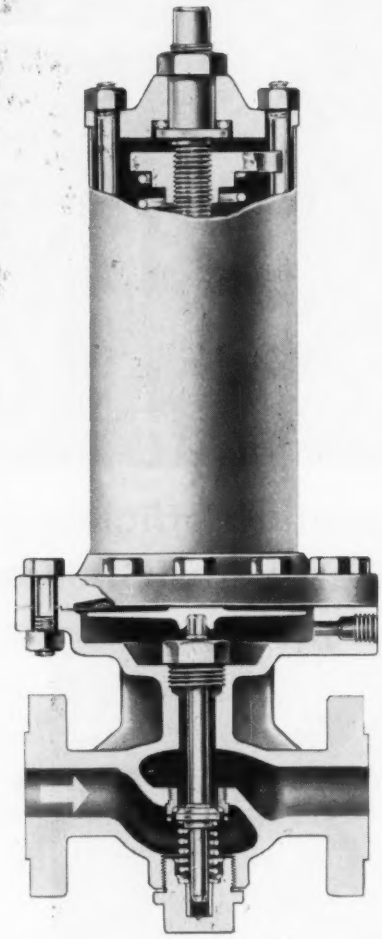
## NEW LESLIE-TOPPER® VALVE DESIGNED WITH PILOTING DEVICE ENTIRELY *OUT OF THE PATH OF STEAM*

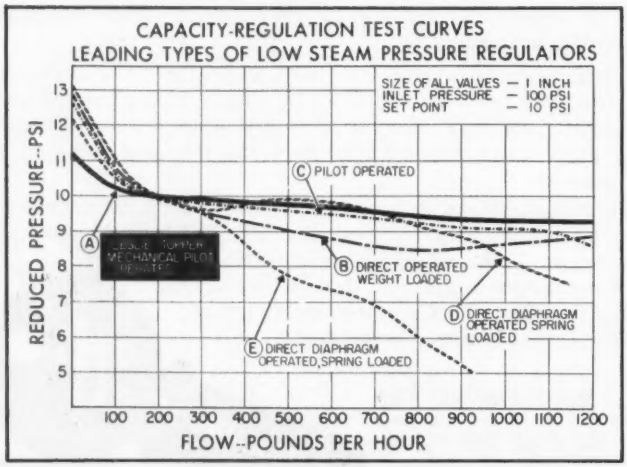
The new Leslie Topper self-contained pressure reducing valve offers a new level of accuracy, simplicity and low-maintenance service (see chart below). Key to this revolutionary valve is a piloting device which is entirely out of the path of steam. Because this mechanical pilot is sealed-off from the steam and all valve parts are designed without dirt-catching passages, the new Topper valve is ideal for both poor steam conditions and intermittent duty.

It can handle low-reduced pressures and is used in process lines, steam heat reducing stations and for make-up steam supply to heaters, gland sealing system and process equipment. You benefit from added reliability, plus the accuracy of a pilot operated valve and the rugged simplicity of direct operation. It means less shut-down time for maintenance, surer pressure control and increased plant efficiency.

**SPECIFICATIONS:**

**Sizes, Body Materials and End Connection:**
**½—2", cast iron, and bronze, screwed, 150 and 300 lb. bronze, flanged.**
**1—2" 125 and 250 lb. cast iron, flanged bodies**
**Three Spring Ranges: 2-10 psi; 5-20 psi; 15-35 psi.**
**Long-travel metal diaphragm: 2 ply, phosphor bronze, Spiro-flex.®**
**Main Valve: Hardened 440C stainless steel.**
**Seat Ring: Stellited stainless steel.**
**Stem Guides: Gun metal bronze (top and bottom guided).**
**Main Valve Spring: Inconel.**






*For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 582.*

LC-8

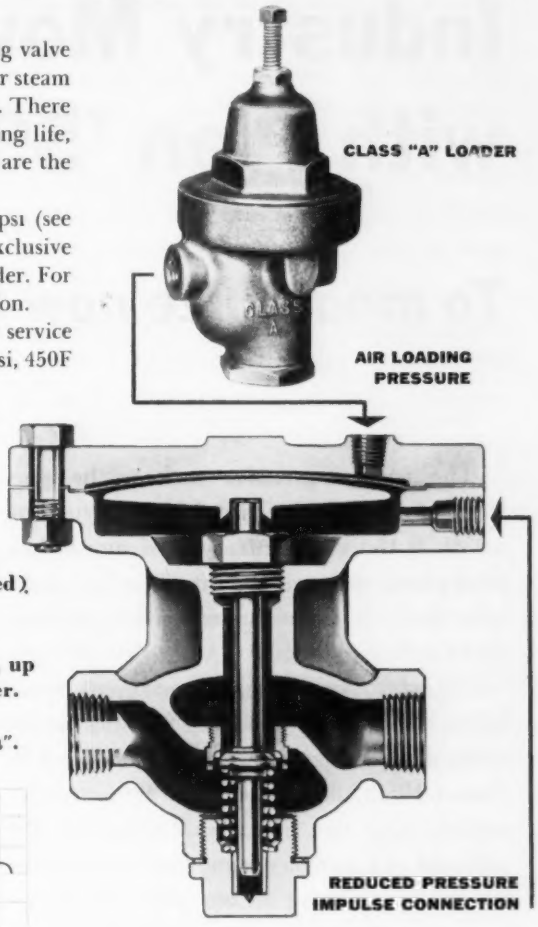
# PRESSURE REDUCING VALVES

## LESLIE AIR-LOADED REDUCING VALVE GUARANTEED MAINTENANCE-FREE FOR THREE FULL YEARS

New Leslie air-top GPK diaphragm operated, pressure reducing valve is guaranteed maintenance-free for three full years. Designed for steam heat or process steam application, it has only two moving parts. There are no seals, no stuffing boxes, no small dirt catching parts. Long life, long-travel diaphragm and hardened stainless steel main valve are the only parts that move.

You get accurate response even to flow changes as small as 0.1 psi (see chart below). This exceptional responsiveness results from exclusive diaphragm design and the accuracy of the simple Leslie air loader. For added flexibility, pressure can be adjusted from remote location.

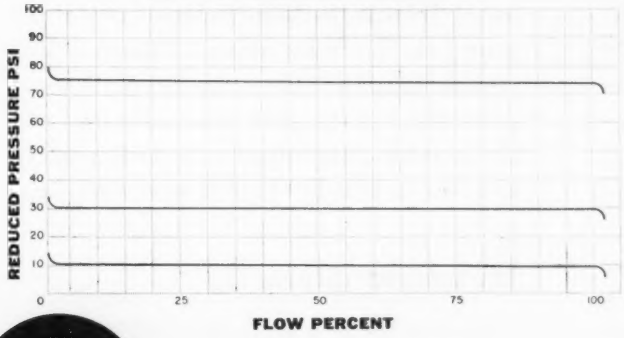
Especially desirable for poor steam conditions and standby service requirements, the GPK is suitable for steam service up to 250 psi, 450F and is available in ½" to 4" sizes.




### SPECIFICATIONS

**Sizes: ½ to 2", cast iron or bronze, screwed ends. 2½, 3 and 4", cast iron, 125 or 250 lb. flanged.**
**Main Valve: Hardened 440C Stainless Steel.**
**Seat Ring: Stellited Stainless Steel.**
**Stem Guides: Gun Metal Bronze (top and bottom guided).**
**Main Valve Spring: Inconel.**
**Inlet Pressure Range: 0-250 psi, 450°F.**
**Reduced Pressure Range: 0-85 psi with Class A loader, up to 249 ½ psi with any suitable high pressure loader.**
**Minimum Pressure Drop across Valve: ½ psi.**
**Available with manual opening device in sizes ½—1¼".**

**CAPACITY-REGULATION GRAPH**




*For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 561-B.*

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# Industry Moves Ahead with Plan '59...

## *To modernize now for growth and profits*

**The most expensive task to be performed in America, in this new year of 1959, is the modernization of our industrial plant and equipment.** This is true despite the huge expenditures on new facilities made in the past decade.

Contrary to popular opinion, and even to much learned opinion, our industrial facilities are not up to date. In a special survey conducted in August 1958, and supplemented by further interviews since that time, the McGraw-Hill Department of Economics found that it would take $95 billion to bring all our plant and equipment up to the best modern standards. This is over $15 billion more than the record budget of the U.S. government for the coming year.

**How did we get so far behind?** It is true that business has made record capital expenditures in recent years, but most of this investment has been to expand capacity. And in concentrating on new capacity, industry has fallen behind on the modernization of older facilities. Meanwhile, the $8 billion a year surge of research and development has brought forth new machines and new processes, at a rate that makes prewar and even early postwar equipment badly obsolete.

The lag between what research has promised —especially in more efficient tools of production —and what has actually been accomplished up to now shows clearly in the AMERICAN MACHINIST inventory of metalworking equipment for 1958. This new study, covering 167 types of equipment in 5,800 metalworking plants, shows that three out of five metalworking machines are over ten years old. This is a startling indication of how obsolete many plants have become. A 1958 machine tool is 54% more productive than one purchased in 1948. Many of the tools industry now uses are actually of 1939, or earlier, design.

### Investment Starts Up

**Now industry's plans for 1959 show a new awareness of the need to modernize.** In its surveys, conducted during the last part of 1958, the McGraw-Hill Department of Economics discovered these facts:

**(1) Companies generally believe that a larger investment in modernization will**

**mean more profits—soon.** Most of the manufacturing companies in the surveys expect their current modernization expenditures to pay off in less than five years. With labor costs rising steadily, it is only with better, more modern equipment that most companies can hope to make these profit gains.

**(2) Industry's plans for modernization have been revised upward.** Total plans for 1959 investment, in new plant and equipment, now come to $33 billion—compared with $31 billion reported earlier. And most of these new plans are directed toward modernization—installing new processes or making ready for new products, developed out of the most recent scientific advances.

It therefore seems clear that modernization expenditures in 1959 will rise enough to make an impressive start on the job of updating our plant and equipment. But it will be no more than a start. Research also is moving ahead with giant strides. Plant expenditures must increase rapidly, from 1958's low level, to win the battle against obsolescence.

## How Can We Modernize Faster?

What can we do to accelerate industry's new drive for more modern plant and equipment? One aid will be an improved flow of technical information on how, and where, to modernize. With this purpose, the McGraw-Hill Publishing Company several months ago inaugurated PLAN '59, a joint effort by all its magazines to spotlight the best opportunities for modernization. During 1959, McGraw-Hill publications will continue this effort by putting special emphasis on new developments in plant and equipment.

On the key problem of financing modernization—the question "Where's the money coming from?"—the McGraw-Hill Department of Economics plans several new studies in the months ahead. The first of these will deal with the number one problem in financing: the need for adequate depreciation allowances. Such studies are a small, but we hope a helpful, part of the total effort that is needed to modernize American industry.

## An Individual Effort

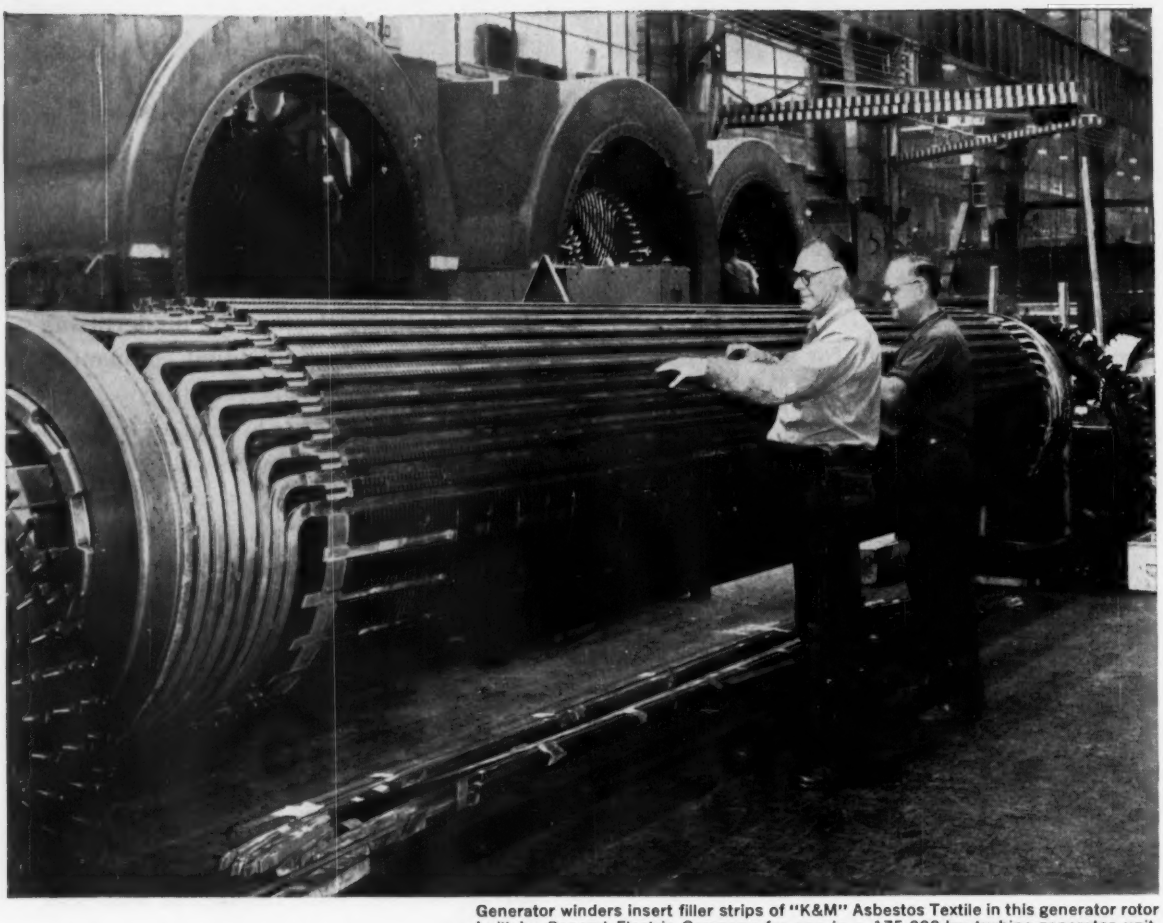
**The really vital steps in modernizing must be taken by individual companies.** The backlog of obsolete plant and equipment is widely dispersed, among firms of all sizes and in all areas. It cannot be wiped out by dynamic equipment policies on the part of a few leading firms. Not just a few, but thousands of industrial companies must take inventory of their respective equipment and compare it, case by case, with the best new machines available.

Finally, there is need for increased public recognition of the modernization problem, and for federal tax policies appropriate to a period of rapid technical change in business.

**The most important point is that the modernization drive has begun. This start can accelerate, with intelligent business and public policies, to give us truly modern industrial facilities. Plant and equipment expenditures are finally beginning to reflect the stepped-up pace of research and development. This can be a major factor in renewed economic growth and prosperity as we move into 1959.**

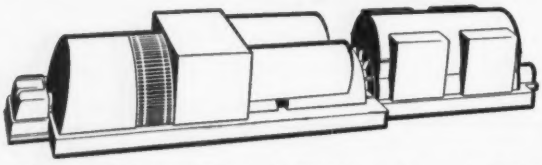
*This message was prepared by the McGraw-Hill Department of Economics as part of our company-wide effort to report on opportunities for modernization in industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.*

Donald C. McGraw
PRESIDENT
McGRAW-HILL PUBLISHING COMPANY, INC.



Generator winders insert filler strips of "K&M" Asbestos Textile in this generator rotor built by General Electric Company for use in a 175,000-kw turbine-generator unit.

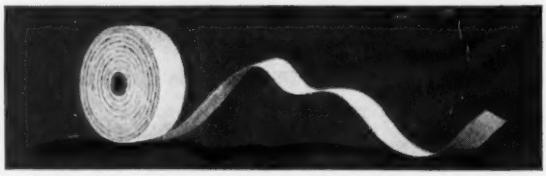
# K&M ASBESTOS TEXTILES provide armor for large powermakers



This 175,000-kw General Electric steam turbine-generator is powerful enough to provide the electrical needs for a community of 280,000 people. And "K&M" Asbestos Textiles help keep equipment such as this on the line.

"K&M" Asbestos Tape has the physical and dielectric stamina and resistance to high temperatures to protect the vital parts of electrical machinery like this. This tape is resilient and stable enough to last the life of the equipment. Excellent absorption of protective insulating or conducting resin treatments enhances the value of this material. This combination of important properties makes "K&M" Asbestos Cloth attractive as a significant part of large G-E turbine-generators.

Fireproof and flexible, "K&M" Asbestos Textiles resist moisture, fire, corrosion, high temperature, and vermin. They insulate against heat, vibration, sound, and electricity. Write to us for more information.



**"K&M" Quality Asbestos Tape for Motors!** "K&M" Asbestos Tape . . . for winding in motors . . . meets the same high standards of quality as does "K&M" Asbestos Textiles for use in G-E powermakers.

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# Giant Butterflies repel clams and mussels...

in steam station's cooling water intake tunnels

COLONIES OF MARINE GROWTH COULD EASILY ENCRUST AND CHOKE THE INTAKE OCEAN PIPELINES OF COASTAL STATIONS. ONE STATION NOW DISCOURAGES THESE MARINE SQUATTERS BY AN UNUSUAL REVERSING CONDENSER COOLING WATER SYSTEM THAT WILL SEND HOT DISCHARGE WATER DOWN THE TUNNEL! HEART OF THE SYSTEM ARE FOUR 132" PRATT BUTTERFLY VALVES OF MONEL* NICKEL-COPPER ALLOY. MONEL ALLOY ASSURES PERMANENT, EFFICIENT OPERATION. IT RESISTS CORROSION BY SEA WATER... EROSION BY THE 400,000 G.P.M. OF PACIFIC OCEAN WATER PASSING THROUGH EACH GIANT VALVE.

*Weaves herringbone twills that are long wearing even in "Hades"*

ASBESTOS YARNS AND WIRES OF MONEL AND INCONEL* NICKEL-CHROMIUM ALLOYS ARE WOVEN INTO HERRINGBONE TWILL JACKETS FOR VALVE PACKING. MONEL WIRE PACKING CAN TAKE 800-900°F AND PRESSURES TO 1500 PSI. INCONEL WIRE PACKING TAKES 1200°F AND 4000 PSI IN ITS STRIDE.

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AS THIS QUICK-ON, QUICK-OFF COUPLING GETS HOT, INCONEL "X"* AGE-HARDENABLE NICKEL-CHROMIUM ALLOY "FINGERS" EXPAND TO GRIP HARDER, SEAL TIGHTER AND TIGHTER. THE SUPERIOR SPRING PROPERTIES OF INCONEL "X" ALLOY ASSURE LEAKPROOF OPERATION FROM -320° F TO +1750° F... FROM 0.8 MICRONS VACUUM TO 8000 PSI.

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# INCO NICKEL ALLOYS



For more facts circle 346 on Reader Service Card, p 117

George Edwards

## says "You can make writing pay off"

In visiting plants around the country I'm often impressed by schemes developed by plant engineers to solve problems or to do something easier and generally at less cost. Many of these are ideas that would be welcomed by engineers in other plants and I invariably tell the guy responsible that he ought to write and tell POWER about it; chances are that it would be published. This means a few bucks for the contributor but, more important, a chunk of publicity that wouldn't do him a bit of harm around his own plant. As a matter of fact, I wrote a little piece, made a couple of sketches to go with it and sent it along to Phil Swain a number of years ago. Phil published it. I thought this was wonderful, but I'll be darned if POWER didn't send me a check for twenty-five bucks to boot. To top it off, our plant's master mechanic saw it, liked it, kept me in mind for a spot I don't think he'd even considered before.

When I realized that POWER *wanted* to hear from plant engineers, I just kept the ball rolling. And a lot of you guys who *could* be doing something like this *should* be doing it. But before you grab a pencil and paper, I want to offer a few tips.

I was in New York gabbling with Lou Rowley and the POWER gang a few weeks ago about this very thing. Actually, that's what prompted this message. It seems that editors get a raft of material—some good, some mediocre, some useless. Odd part is, some of the best material they get from contributors is difficult to whip into shape for publication. Steve Elonka *(Practical Ideas)* and Bob Marks *(Plant Problems)*, in particular, told me that this was one of their toughest problems.

A few simple rules are all that are necessary to avoid killing your chances of getting something published, assuming it's a good piece: (1) If you don't have a typewriter, write it *clearly* or, better yet, print it and leave enough space between the lines for editors' markings. (2) Don't worry too much about literary style. But, in line with this, I think it would be smart if you studied POWER's style and tried to imitate it. (3) Write only on *one* side of the sheet of paper. Paper is cheap, don't try to say everything on one page. (4) Put *each* sketch or drawing on a separate sheet, and use standard terms in identifying equipment. (5) If you use photos, make your subject the *main* part of the picture. Make it stand out. If it's a lever-operated widget, show someone operating the lever. Try to avoid unnecessary background detail such as tools lying around, dirty workbench, other people or equipment having no bearing on your story.

Tell your story simply: What was the problem? What did you do about it? What are the results? These are the basics of any good article. Follow them and before you know it you'll be writing feature articles for POWER or any magazine you choose. You'll be surprised, too, how those little checks can add up to real dough each month.

# How to get a safer, clearer look inside at 500°F.

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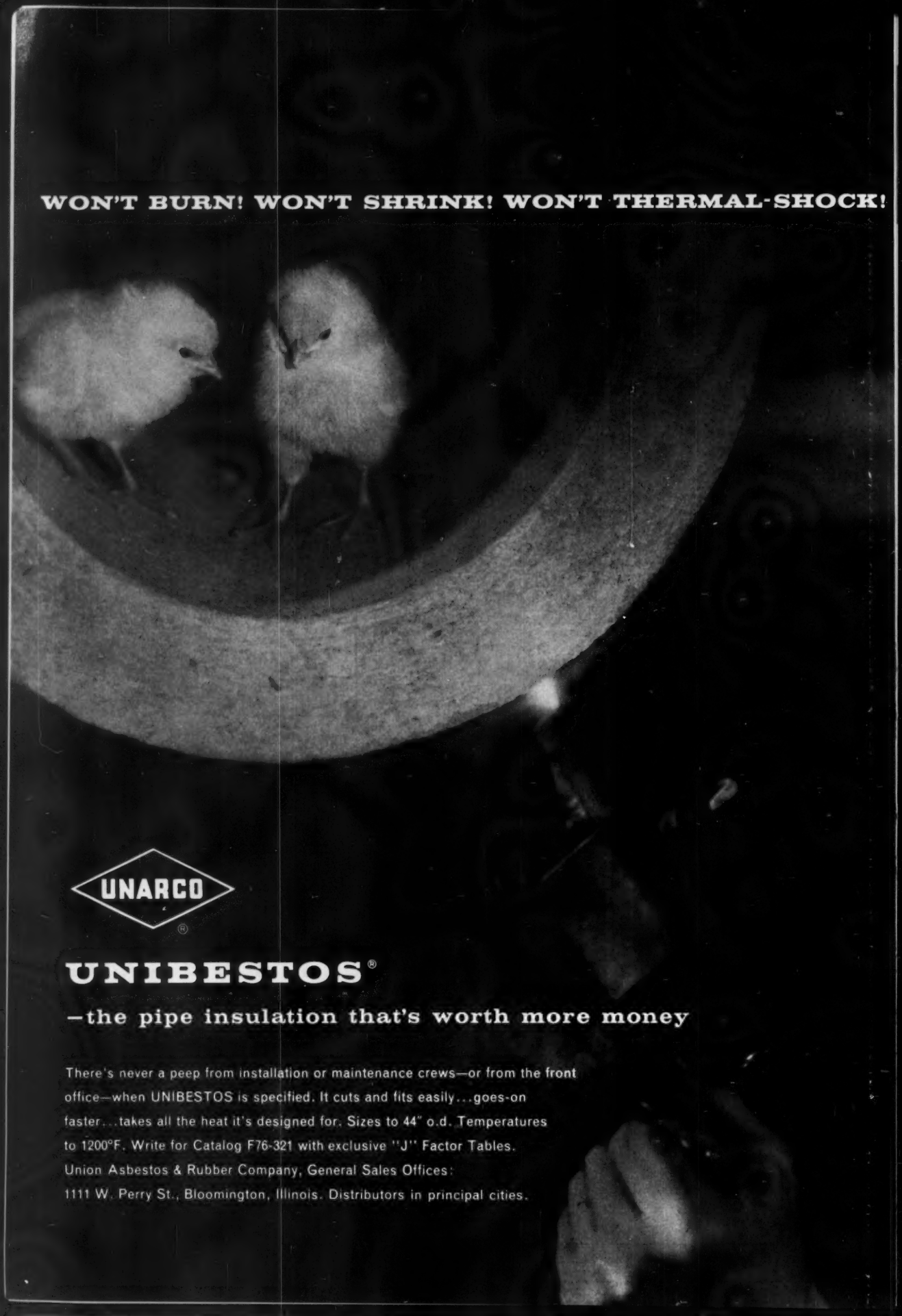
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STEVE ELONKA
Associate Editor in Charge

# Epoxy resins . . .

**. . . are gaining favor with power-service engineers as a top maintenance aid. Used mainly for coatings, their chemical resistance and adhesive properties outweigh their high material cost. Here's what they are doing in today's plants**

By J W FOLLANSBEE
Assistant Editor

Engineers recently licked two of the major drawbacks to epoxy-resin application. A spray gun introduced last fall trims the high cost of hand labor and the problems of short pot life. Now power-service engineers can add epoxies as a maintenance aid in areas once blocked by price.

The list of epoxy qualities of interest to power engineers is long. By mixing the resin with the right ingredients you can produce a coating, adhesive or filler that's tough, durable, heat and chemical resistant. These are on the plus side. On the negative side are long cure times and high material cost.

Before getting into applications let's see what epoxies are and how they're used. The final product, your coating or adhesive, is a plastic formed by mixing an organic resin and a curing agent. The mixing process is similar to working up cement. To make a batch, carefully proportioned amounts of resin and curing agent are thoroughly blended. This produces a chemical reaction that, like cement, releases heat. The amount of heat produced is tied closely to (1) types of resin and curing agent and (2) the quantity mixed at one time. As with cement, if you mix too much at once you can ruin the batch. In the case of epoxies, excess heat will boil or char the mixture.

Again, similar to cement, there's a time limit that governs when the mix initially sets up or gels, and also a curing or aging period that must pass before the mix reaches maximum strength. About 95% of epoxies have short gel periods (30 minutes to 2 hours) and cure times of 2 to 7 days. These periods are for room temperature applications. Both gel and cure times can be shortened by raising the cure temperature to 200 F or higher; time needed at the high temperature depends on the blend.

Most epoxies have a heat distortion or softening point between 180 and 200 F when cured at room temperatures. You can boost this point to 220 F or higher by a 2-hour post cure bake at 200 to 300 F; for small jobs heat lamps are the easiest bake method. There are epoxies with heat distortion points between 300 to 500 F, but they are special blends requiring high cure temperatures and other limitations for general applications.

Gel time, called pot life, is the biggest problem. This is the time it takes the blend to set up. Once the ingredients are mixed you must apply them before they gel or the mix will harden in the pot. For jobs of long applica-

## Epoxies are chemical, abrasion resistant but softening point is

tion times, the answer usually has to be several batches mixed as needed.

All these factors—gel and cure time, cure and distortion temperatures—result from the combination of resin, curing agent and filler you select. Filling agents, unlike the resin, are usually inorganic and are added to control heat produced by the chemical reaction, machinability, thermal properties. The variety of end results is wide, so check with your epoxy distributor on which blend to use for your application.

One solution to some of these problems is the spray gun. Resin and hardener start out in different containers and don't meet until they reach a mixing chamber just in back of the nozzle. The blend is then atomized as it leaves the nozzle. Because of the short time between mixing and applying pot life is infinite, so the gun lets you use blends with a short cure period without worrying about the mix gelling in the pot. Gun and accessory equipment (pumps, containers, hoses) are portable—87 lb complete—so you can use them in most plant areas. Advantage to spraying is reduction in labor. The gun does not replace all other methods; it is best where labor costs are too high. Small jobs are not generally applications where labor is of top concern and the gun is one of several methods by which you can apply the mixture at reasonable cost.

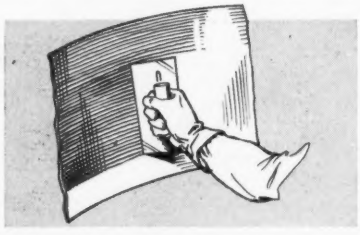
**APPLICATIONS.** Epoxy resins fall into three broad application categories: coatings, adhesives and fillers.

**COATINGS.** Tanks, bunkers, pipes, storage bins—any surface you want to protect against chemical, water or abrasion attack is a candidate for epoxies. The most important point to remember is the temperature of the application; if it's higher than room temperature check it against the mix softening point.

There are several ways to apply the mix in coating form. The main guide to the best method for any job will be the protection you want and the type of surface you're working with.

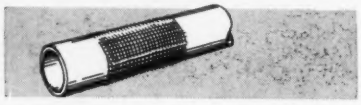
**PAINTING** is best used for small areas needing a light coat. Small diameter pipes are a good example. The pipe area in front of the worker is small even though total pipe area might be large. The worker can get to both sides of the pipe with a brush and apply the right thickness easier than with other methods. Spraying is faster for each pass but slower between passes. Getting the gun positioned around the pipe takes longer than brushing. Also, if the job is large, spraying small pipes might represent excessive waste.

**SPRAYING** fits large areas needing a light coat for chemical or water resistance. Also rough surfaces and irregular shapes to receive light or medium coats, regardless of size, are candidates for the gun. Gun's main advantage is elimination of pot life and fast application of thin coats—a few mills. It is not the best method for all applications.



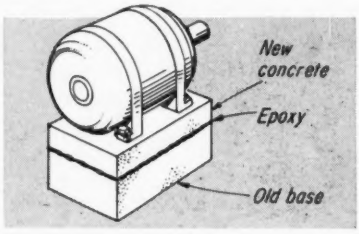
**TROWELLING** is a third approach. Abrasion-resistant coatings normally are heavier than corrosion-resistant coverings. Although you can use either a gun or brush on heavy coatings a trowel can do the job faster if the coat is heavy enough. Area, thickness and surface roughness are your guideposts to the proper choice.

**ADHESIVES.** Epoxies are one of the best organic adhesives. They'll bond with metal, glass, wood, ceramics, concrete and most rubbers. This gluing ability is one of the key points that lend epoxies to maintenance work in the power-service field.



**PIPE REPAIR.** Fix leaking pipes with a sandwich of epoxies and cloth. Coat area around leak with epoxy; then, while it's still wet, lay on a patch of some coarse woven cloth (glass fiber is good; others will do). Finally put on a second epoxy coat over the mesh. Technique is good for pipes carrying flammable gases, refrigerant, room temperature water. One advantage to technique is ease of working on hard-to-get-to leaks. Again remember the temperature limitation of epoxies when considering them for pipe patching.

For general repair the patch technique applies to ripped welding helmets and torn sheet metal; a straight gluing job will work for securing tool bits to holders and repairing broken castings such as gear teeth.

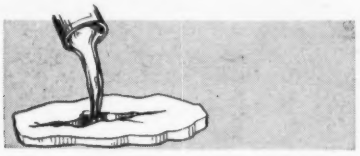



**CONCRETE REPAIR.** Epoxies will bond with cement and can be used to repair concrete equipment bases. Motors, compressors, pumps, small turbine drives are often changed, which means revamping the bases if bolt hole placement or shaft height is different. Epoxies can be used to hold the new concrete top to the old base. After grouting out the top, clean the base and pour or paint on a layer of epoxy. Then pour the fresh concrete over the wet epoxy and let it dry.

Once the bond cures the two lay-

## between 180 and 200 F

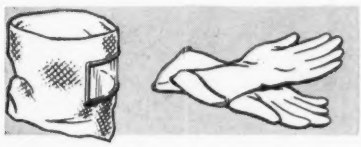
ers will cling together with a strength greater than the tensile strength of concrete. But this adhesion strength brings up one problem. The coefficient of expansion of epoxies is greater than concrete and if the base is in an area subject to fast and wide temperature fluctuations (say an 80 to 100 F spread in 3 or 4 hours) the epoxy might split the concrete.



**FILLERS.** Epoxies are also used to fill cracks and cavities such as blowholes in sprockets. Repair cracks and shallow holes by pouring or painting rather than the patch technique. Depth and width of the crack will give you the best lead as to the proper method to use.

Sealing falls under filling applications. Observation windows and pipe joints that develop leaks are typical seal problems. They require chemical resistance and good adhesion. Since epoxies compete with other sealants, price and application limitations will determine their use.

**ENCAPSULATION.** Maintenance and design engineers in the electrical field are familiar with epoxies. Ever since epoxy production started seven years ago they have been used on motor coils, solenoid and voltage coils, and collector rings as well as many components in the electronic areas. Main advantages are reducing vibration damage, resistance to contamination by chemicals and water, providing a seal free of entrained air bubbles.



**HAZARDS.** Epoxy resins and their curing agents are skin irritants. Generally the resins are not as bad as the hardeners, but both will cause rashes or burns. Initial exposure doesn't always cause irritation, but the skin often develops a sensitivity after weeks or months of exposure and then the rash appears.

Although protective clothing—helmets, gloves, coveralls—is called for, the greatest protection is education. This is especially true for repair work where the worker isn't using epoxies every day and easily forgets that they can hurt him. Reminders that come up when the men go to the epoxy storage bin are typical of efforts needed to prevent accidents.

If someone does get the mixture or any of the ingredients on him, have him wash his skin first with denatured alcohol, then with soap and water. The purpose of protective clothing is defeated if it is contaminated on the inside. If this happens don't let workers wear it until clothing is cleaned. If you're going to do a lot of small jobs with epoxies do them in one small area of the plant if possible, to keep down exposure hazard.

Spray techniques call for good ventilation regardless of where gun is used. The fine droplets are a hazard to lungs and eyes as well as skin. Painted or trowelled epoxies are also hazards to eyes but not so serious as the spray. Good housekeeping practices pay off when using epoxies by automatically keeping exposure risks of the workers to a minimum.

### Formulators make it easy for the users

Producers of the raw materials generally don't sell direct to the ultimate users in the power field. Bakelite, Ciba, Dow, Jones-Dabney, Shell all sell mainly to middlemen who formulate and package various blends. Many formulators, such as Houghton Labs Inc, package the resin and curing agent in preproportioned containers so blending ratios are automatically correct. Tubes, above, have proportioned openings so all user has to do is squeeze out two equal lengths of material, blend and apply. Same idea is seen in different sized cans, with an empty space in the larger can ready to receive the contents of the smaller can (larger for resin, smaller for hardener). These formulators also are qualified to work up special blends if you need them. If you can't find a formulator or distributor locally, check with the producers of the raw epoxies.

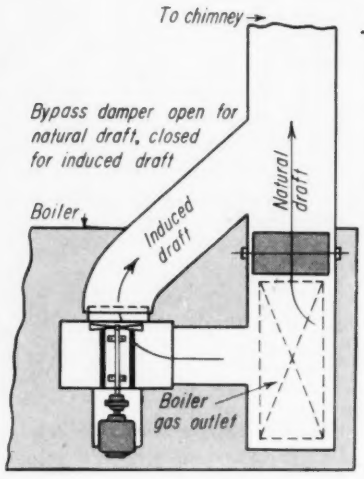
### Correction

On page 77, POWER Feb 1959, (third page of article "High heat transfer for stainless") two rows of figures were reversed in the test data tabulations. Row starting 33.0 in the arsenical-admiralty side of Test No. 8 should be opposite *Terminal difference;* row starting 1.87 should be opposite *Condenser abs press., in. Hg.*

OPERATORS' NOTEBOOK **128**

# Today, draft inducers can

**PENTHOUSE FURNACE ROOM** of new Temple University classroom building frees valuable basement floor space for other uses. Draft inducer replaces an ungainly smokestack




**STEAM** generating capacity is greatly increased with this draft-inducer hookup

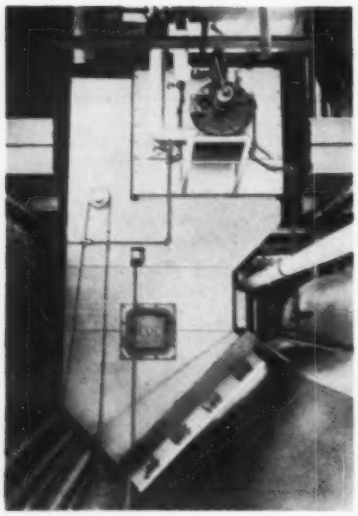
## What you should know about draft inducers

You see fewer and fewer tall chimneys on today's low-silhouette buildings, such as schools, factories, shopping centers and large apartment houses. Instead, an induced-draft fan is used to draw the combustion gas through the boiler. Then, only a short-stub stack is required to vent the flue gas to the outside. Result: clean, low silhouettes.

The beautiful Temple University classroom building, photo, is a good example of modern architecture. Here the furnace room is in the roof penthouse. There are two boilers, with a draft inducer installed on each boiler.

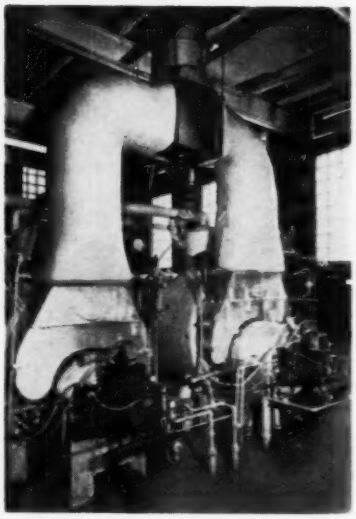
**Draft inducer** has the advantage of creating a dependable, steady flow of air to suit combustion needs. Natural draft varies with the outside temperature, outside humidity and direction and force of the wind. It's also affected by hills and neighboring tall buildings. Natural draft varies with stack-gas temperature because a

## There are many ways to install draft inducers



**SPACE ECONOMY.** Inducers of the axial flow type can be fitted into tight spaces, as shown at left. Here the draft inducer fits into the elbow normally used for this breeching; it requires no additional space. This hookup permits a bypass for low-load operation or even for natural draft. Savings in both space and money point up importance of this unique hookup.

**MULTI-BOILER INSTALLATION.** Here the draft inducer takes up no more space than is needed for the T in this breeching. Boilers can be run singly or together. The barometric damper is on an extra inlet and maintains draft control. Standard unit has three inlets, which is good for horizontal or vertical discharge to meet the many installation requirements



# solve your installation problems

By STEVE ELONKA, Associate Editor

cold stack doesn't provide as much draft as a stack that is heated by flue gas. Another fault of a cold stack: on startup it causes an excessive amount of smoke.

Common practice for power boilers is to have an induced-draft fan as well as a blower. Here the blower forces air into contact with the fuel for a more concentrated combustion. The draft inducer draws the gas through the boiler and vents it to atmosphere. Point of balance occurs in the furnace, which is maintained at a slight negative pressure of –0.10 in. or less. This negative pressure guards against the danger of gas leaking out into the boiler room. This means that with more concentrated combustion and higher velocities through the heat-transfer area, greater steaming capacity is obtainable in a given space.

**Induced-draft fans** are rarely used by themselves. Even the domestic burner has a blower, while industrial burners have primary air blowers or even blowers that handle the entire air requirements of the installation.

One of the big advantages of an induced-draft fan is that it keeps gas from leaking through the boiler casing. But the present-day trend toward completely sealed and gastight boilers is doing away with both the induced-draft fan and tall chimneys. In these cases a blower pushes the gas through the boiler.

While the trend toward pressurized furnaces has worked well with larger power boilers, the story with smaller heating boilers is quite another tale. Here the boiler room is often unattended, so leakage is a safety hazard because a delicate balance of fuel-air ratio must be kept. Leakage dangers in unattended boiler rooms are minimized by using induced-draft fans with fail-safe controls.

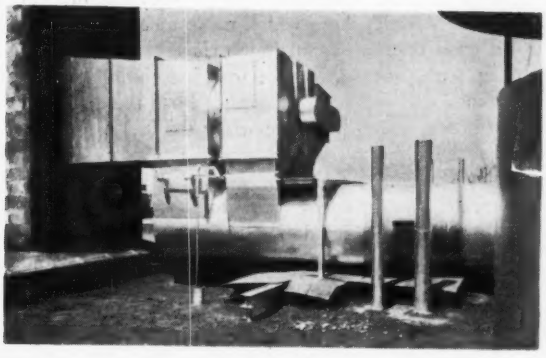
The flow of gas is always maintained at the correct rate with a mechanical-draft inducer—at startup, on cold or hot days, with strong or light winds.

While excess natural draft can be controlled with dampers, the operator doesn't always have enough draft available to permit control. But a draft inducer can be selected to handle the most severe conditions with convenient controls for reduced requirements. There are various types of induced-draft fans. One common type has a motor-driven airfoil fan in a metal housing that is part of the breeching or flue of the stack.

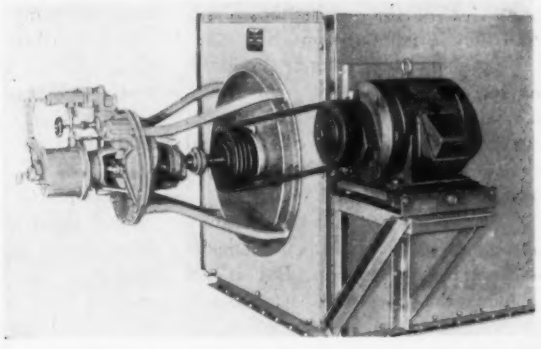
Draft inducers can be used on both heating and power boilers. Variable-speed drives provide (1) the most efficient operation (2) the most convention draft adjustment and (3) the lowest electrical costs. V-belt drives eliminate the chance of misalignment caused by expansion and contraction because they're not as rigid as coupling drives.

**Variable-speed motors** permit running at high speeds for full-load operation and at lower speeds for keeping steam pressure at lower steam demands. But induced-draft fans are also direct driven by a motor or steam turbine. Some jobs combine a turbine and electric motor.

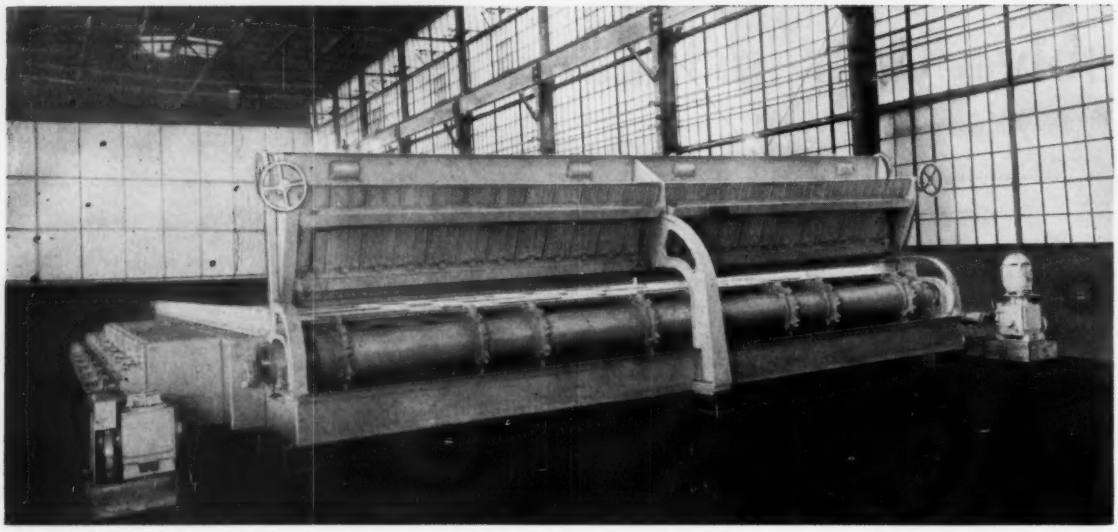
Place induced-draft fans directly in the breeching between the boiler and stack. If the stack is separated from the boiler room, install the fan outdoors in the breeching.—*Courtesy, L J Wing Mfg Co, Linden, N. J.*



**BYPASS ARRANGEMENT,** shown on roof, has draft inducer serving a food-processing plant of two 20,000-lb-per-hr stoker-fired boilers. Each boiler has its own individual connection. Bypass with damper permits natural draft at low loads. Because the unit is a compact packaged design and of light weight, and because it runs smoothly, it is supported entirely on a common breeching



**DUAL DRIVE** is a compact motor- and turbine-driven unit. Reason for two drives is to provide maximum protection against power failure. Too, it utilizes the turbine-exhaust steam for process, reducing steam-generating costs. Drive changeover is accomplished merely by turning a valve and pushing a starter button. Packaged with drives, vibration-free inducer needs no structural support



**WIDE APPLICATION** of the traveling-grate stoker makes it a leader in the field of solid-fuels firing. Though designed to cope with rugged service conditions, performance can be adversely affected by neglecting to consider some basic operating principles

**Good stoker operation means savings. Good maintenance means that management, not the stoker, decides when there'll be an outage. These tips will help you . . .**

# Get acquainted with traveling-grate stokers

By L J COHAN
Combustion Engineering, Inc

It would be difficult to overemphasize the traveling-grate stoker's importance in industry. Millions of tons of coal are burned each year on these units for steam production alone. And they're front runners in the firing-equipment field in their adaptability for special processes such as municipal and industrial incineration, continuous production of chemical coke and lightweight aggregate for building materials.

Unquestionably, stoker operation and maintenance presents a challenge to power-plant people. But it's a challenge in which dollar savings can be realized. Unlike many other firing methods, it's difficult to isolate a stoker from a boiler for maintenance purposes. However, high availability is a must to protect the capital investment, and an understanding of factors considered in stoker design is important if a unit is to give maximum service at lowest possible cost.

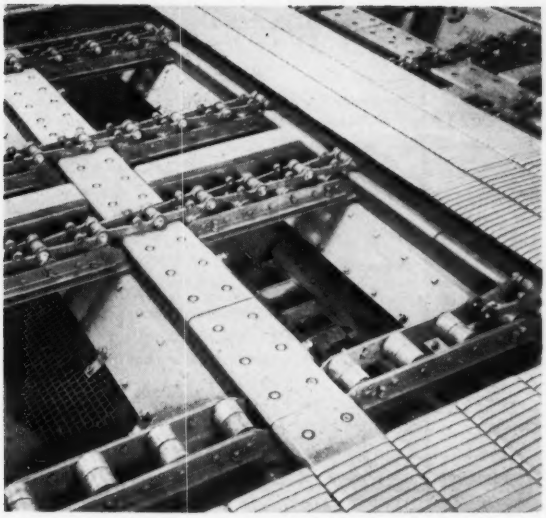
Let's begin with a brief look at basic traveling-grate-stoker design principles, then touch on good operating methods and wind up with preventive-maintenance schedules.

**Traveling-grate stokers** are front feed or progressive burning. Fuel feeds in a uniform layer onto a continuously moving grate. Rate of fuel input is varied by adjusting grate speed and changing fuel-bed thickness. Fundamentally, both bar-and-key and chain-grate machines are traveling-grate stokers and, through usage, the terms have been interchanged. However, there is a physical or mechanical difference.

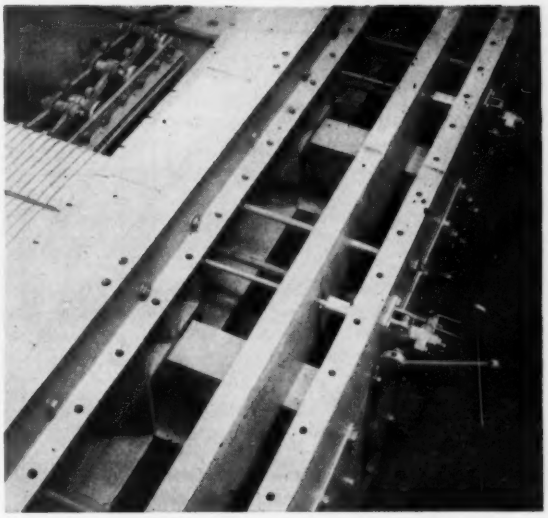
**Bar-and-key stoker** consists of a series of links connected by bars or pins to two or more chains. The chains are mounted on and rotate between parallel shafts. The bars support cast-iron or alloy sections called keys which make up the endless fuel-supporting surface. Chain-grate type differs in that individual links connected together form the endless surface supporting the fuel bed.

A fuel supply hopper is used with each type and each uses a variable-speed drive to move the stoker and regulate fuel feed. Air must be supplied and regulated for good combustion. Siftings and ashes must be removed to complete the firing process necessary for high heat release.

**Operating problems** are nearly similar regardless of whether fuel is anthracite or bituminous coal. Type of fuel influences furnace and stoker design which remains unchanged un-



**RUNNING GEAR** maintenance, particularly of smaller components, can spell the difference between high or normal operating costs



**MASSIVE CONSTRUCTION** reflects the design for long life. But, as with any machine, alignment and clearances must be kept

less an existing installation is converted from anthracite to bituminous firing. However, these are factors that the operator cannot control. He's concerned with getting **top** performance with the fuel at hand.

Fuel may be purchased in accordance with the stoker manufacturer's specs but this doesn't mean that you'll get the coal specified. Since both bar-and-key and chain-grate stokers are sensitive to over- and undersize coal it's wise to make frequent size checks. A simple screen check of coal as received can do much to head off firing problems.

Even if you receive coal as specified it isn't uncommon to wind up with poor size consist due to degradation or segregation. Coal may arrive at your plant in ideal size consist for the stoker but is handled and rehandled in such a manner that it's badly segregated by the time it gets to the stoker grate. Instead of jumping to the conclusion that a change in fuel sizing is the only solution to a firing problem, it might be well for you to take a hard look at the fuel-handling procedure in your plant.

**Good combustion** requires a porous fuel bed which allows uniform air distribution. In a well-designed stoker, factors such as grate and fuel-bed resistance and stoker leakage may disturb air flow, and must be considered. Amount of grate resistance is fixed by design of fuel-supporting surfaces, velocities in various compartments and air admission ducts. Fuel resistance is a function of coal sizing and distribution. Stoker leakage usually isn't a factor in a well-erected machine. It can be serious if a new machine is poorly erected or an older unit is badly neglected.

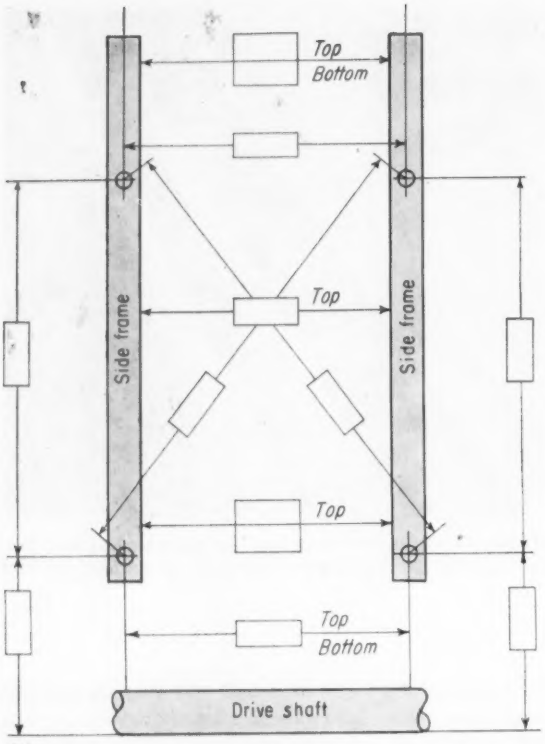
Stoker designers know the importance of controlled, uniform air distribution. Considering the difficulty in holding close tolerances on multiple rough castings, they use a fixed-leakage factor (a small percentage of primary air through the grate). It follows, then, that it is leakage through other areas that affects stoker performance. Uncontrolled leakage in boiler setting or ashpits has further adverse effect on overall performance.

**Operator's skill** is probably taxed in a plant having wide load variation. Within limits a traveling-grate stoker performs well, but some conditions such as summer heating loads can impose problems that go beyond design considerations. Basically, fuel-burning area is fixed by design, units are compartmented to regulate and distribute air flow, stoker speed range is fixed for a given drive. If your plant has more than one stoker, and sizes are different, there's more operating latitude, so gear maintenance to take advantage of this flexibility. It's better to operate a unit near its peak capacity and exceed it for short periods, than to use larger or multiple units just to handle short peaks.

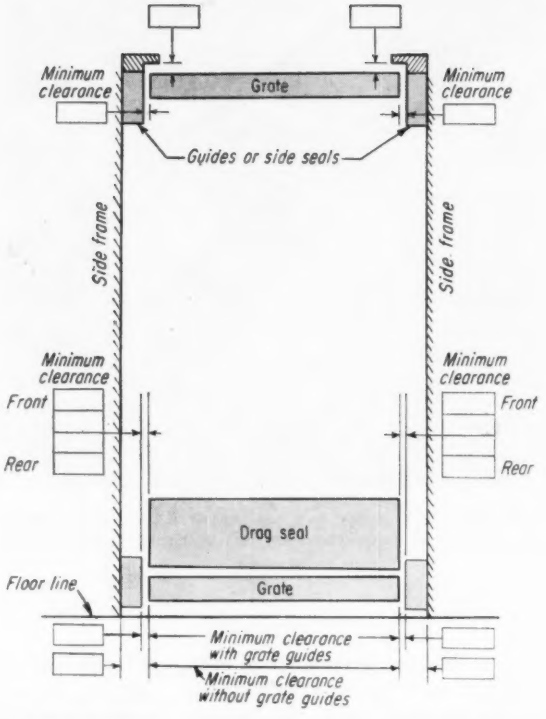
With single units, or multiple units of similar size, operating problems can be more complex. If light loads are to be sustained for several months or longer, it might be advisable to check with the stoker manufacturer on changing minimum speeds. Thermocouples temporarily located in the grate surface are helpful in establishing a good fuel bed thickness — grate speed relationship.

If load variations occur daily or hourly in your plant, schedule ash cleaning to tie in with favorable conditions. Daily flowchart study will enable your operators to anticipate load swings and adjust firing rates. With automatic combustion controls, it's often necessary to shift to hand control for low-load operation. In most cases, turndown on a stoker is greater than that of its control system. If only a heating load, it may be more economical to take minor pressure drops rather than try to hold pressure constant at expense of stable ignition, high ashpit carbon loss.

**Banking a unit** overnight or on week ends is not only one of the most common practices, but one of the least understood. Maybe it's because pushing a fan stop button, closing a turbine valve and closing dampers




**CLEARANCE AND ALIGNMENT** diagram is useful in stoker maintenance. It's a plan-view recording of all pertinent dimensions




**SIDE CLEARANCES** can be recorded on a front-elevation diagram. Get information on older unit when it's stripped for inspection

are relatively unskilled operations. But proper banking means much more than this. First, prepare the fuel bed, then empty ashpits to prevent radiant heat from hot ashes onto exposed grates. Statistically, there's evidence to prove that stoker maintenance is higher in plants where banking is frequent. And, just as important, is the way a bank is broken. How well you can re-establish an active fuel bed is a direct result of the banking technique used in your plant.

Most critical factor in frequent banking is to avoid grate overheating when going into bank. A good general procedure (certainly not intended to conflict with manufacturers' instructions) is: (1) Reduce load to about 30% of capacity for about half an hour before starting to bank. (2) Stop grate and leave air on. (3) Progressively burn back to nose of rear arch (if so equipped), then cut off all air and close compartment dampers. Stop f-d fan, overfire air and cinder recovery blowers. (4) Raise fuel gate about 10-in. Height will vary depending upon length of bank period. (5) Move active fire to center of last compartment. (6) Close boiler outlet damper to a point which will maintain a slight negative pressure. (7) Periodically advance stoker to hold active bank over rear compartment. This means that your operator should observe bank frequently to keep it from burning down and damaging stoker.

When bringing unit back into service from a bank, open boiler outlet damper slightly and start f-d fan. Next, gradually open dampers under banked fuel bed. Fuel will soon begin to burn. Adjust boiler outlet damper and air supply to compartments to provide a slight furnace draft. As fuel bed brightens, open boiler damper a little more and increase stoker compartments air pressure. Run stoker occasionally for a foot or so to prevent fuel bed from burning too short. Continuing this process will ignite fuel bed sufficiently to allow continuous stoker operation. Control fuel-bed thickness by lowering regulating gate to a point consistent with normal operation and plant load. Now you can start overfire air and cinder return systems. Since some unburned fuel may have been discharged into the ashpit during rekindling, it's a good idea to clean the ashpit again.

**Role of plant personnel** in overall stoker operation is very important. A skilled operator and capable supervisor anticipate problems and make corrections before a situation gets out of hand. Automatic equipment complements intelligent operation and means dollars savings, but it isn't wise to consider it a substitute for a good operator. Unreliable instrumentation isn't of any more value than unobservant attendants.

Good operating procedures pay dividends by increasing stoker life and length of time between boiler outages. Unscheduled outages not only cost money but often happen at

## Typical annual overhaul program

1 Disassemble removable ledge plates from fixed ledge plates. Removable ledge plates should clear top of bar-end key by at least 1/16 in. and must be loose in fixed ledge plate

2 With removable ledge plates disassembled, check clearance between bar-end key and top of frame protecting castings

3 Ride the machine around for one complete revolution and note if the above clearance is maintained

4 If clearance isn't maintained, check chain tension. Grate should contact return rail shoes at a specified point in front of the center line of the rear shaft

5 Run machine, observe for signs of misalignment

6 Remove at least six carrier bars across width of stoker. Run leading edge of this opening to center of first compartment

7 Check alignment of sprockets, chain. Be sure sprockets are tight, not worn. There should be clearance between protruding lug on carrier bars and sprocket teeth

8 Ride the opening through the stoker, progressively checking the compartment seal plates and skids for elevation. Shim or replace if necessary

9 Check for air leaks in each compartment, around dampers, corners and all points where surfaces butt or lap. Seal at all points of leakage. Check sifting removal equipment and repair or replace where necessary

10 As the rear end of the grate opening starts exposing the rear compartment, remove sufficient bars from the front end of the opening so as to expose both front and rear shafts

11 Check rear sprockets in same manner as outlined in Item 7

12 With both shafts exposed, check them for square with side frame and make sure they're parallel with each other

13 Check return rail shoes at front and rear. Check for level and elevation in both directions. Center line of return rails should be under the center line of chains and centered with sprockets at the front and rear

14 Space between the bottom run of the grate and the foundation must be clear of debris

15 Check grate assembly. There should be a minimum recommended clearance between keys when the keys are forced together. Check condition of cotter pins, connecting pins

16 Check regulating gate and reset indices if necessary

17 Replace badly worn parts; they're cheaper than an outage

18 Reassemble machine in its entirety

19 Flush out and relubricate

20 Run stoker at highest speed for 24 hr before using

21 Make a record of all parts used, then reorder for next year

the worst possible times. In institutions such as hospitals, a breakdown outage can cause serious after-effects.

**Maintenance** falls into two general groups: daily and preventive. The former means looking after all items necessary to insure dependable day-to-day operation. The latter is a matter of inspection and attention in a well-planned, well-executed, way.

Lubrication is as important to stokers as it is to other machines. And this means the right lubricant at the right times in the right places. Trouble stemming from inadequate lubrication is usually from lack of attention rather than lack of knowledge of how, when and where to lubricate. There's no excuse for lack of knowledge because stoker manufacturers stand ready and willing to assist with any lubrication problem.

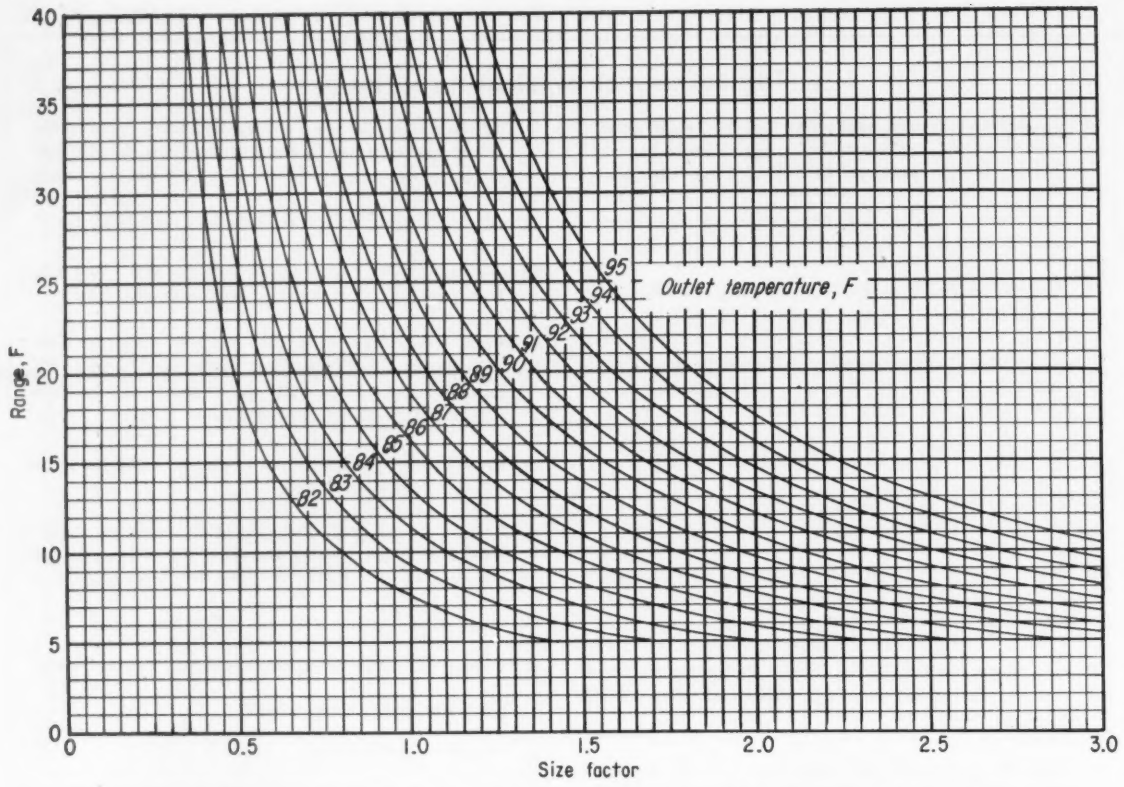
**Daily inspection** should pay particular attention to loose connections in moving parts. Where shear pins or safety releases are involved, be sure there's no binding which might interfere with their function. Even though tempted by the need to operate the machine, never install a solid shear pin. Generally, the pin protects the drive and it's much costlier to replace a drive than a component.

Replace broken keys immediately, burned keys as soon as possible. A piece of cast iron falling into chain runs can do a lot of damage. Too, holes in grate surface increase accumulation of siftings. This means, at best, a higher carbon loss and, at worst, a serious internal fire.

Daily inspection logging is a good way to make sure that items needing attention won't be overlooked during a scheduled outage. Items considered unimportant have a way of developing and causing a forced shutdown. Logging items, regardless of their apparent unimportance, makes for efficient preventive maintenance.

Annual maintenance costs can reflect the manner of stoker erection. Importance of good alignment can't be overestimated. Poor alignment can be a source of continuous maintenance. Drawing, left, p 214, is a typical clearance and alignment diagram for recording all pertinent dimensions. Such a diagram can be most useful in maintaining stokers. Drawing, right, p 214, is used in a similar manner and provides means for recording side clearances. Although this information isn't recorded on older machines, it doesn't prevent you from using this method to record alignment and clearances on existing units. The information can be gathered when the machine is stripped for annual maintenance and in later years the effort will pay off.

Schedule thorough overhaul and replacement at least annually and plan for next year's outage as soon as you complete the present one. This gives time to stock parts and consider improved operating techniques and daily routine checks. In substance, planning and a more intimate knowledge of basic stoker needs can't help but give improved operation.




**1** Flow rate changes alter the cooling-tower size factor and outlet water values. Curves are plotted for 77-F wet-bulb temperature

**Paper work of cooling-tower performance checks has been cut from hours to minutes. Now you can use these charts to . . .**

# Run cooling-tower tests the easy way

By E L BASS and N P GREEN, N P Green and Associates, St. Louis, Mo.

Working out cooling-tower performance ratings, once a tedious chore, is now simple and fast. A graphical method replaces complicated calculations so that even a non-engineer can keep tabs on tower performance.

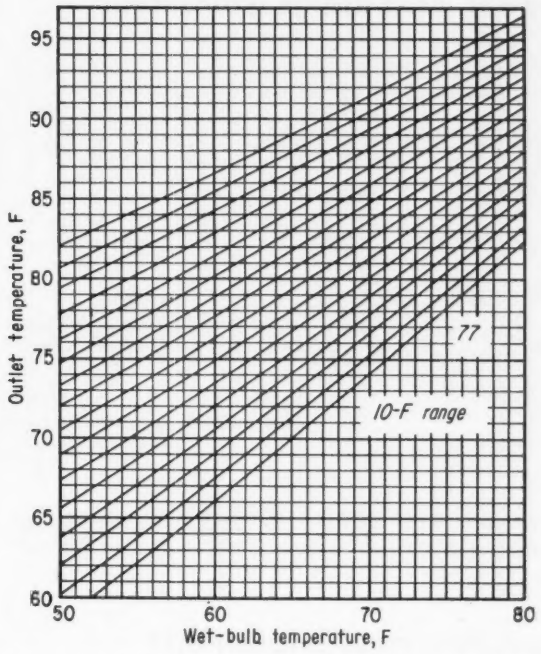
**Importance of charts** is their simplicity—the ease with which you can (1) check tower against guarantee (2) predict effect of loading changes (3) tell if tower is doing well compared with past performance.

Most tower operators don't find it easy to determine just how their towers are doing, since a tower rarely works at design loading conditions. Heat load, flow rate, wet-bulb temperature—all these may differ from load data stated in the guarantee. Graphical method relates these variables in a few easy steps, keeping work of problem solving to a minimum regardless of how many variables differ from design loading conditions.

**Power-service engineers** also want to know effect of changing present operating conditions. For instance, suppose you want to step up condenser's heat-transfer coefficient. One way is to boost flow rates through tower and condenser. Since this will raise temperature of water leaving the tower, you need a method of finding that value before you can justify the extra pumping costs.

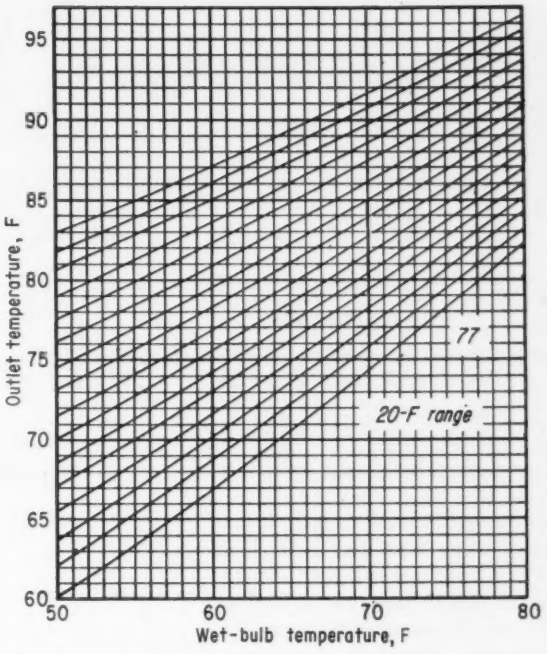
Finally, curves simplify tower efficiency checks. Once you've run one test you can relate any future tests to the first one, or relate all tests to the guarantee. Charts help in all three of the above situations by giving the operator a quick, sure way to get answers.

**Two restrictions** apply to chart method. First, flow rate cannot vary more than 20% from design value or charts will be invalid. Reason for this is tied in with second restriction: Changes in physical arrangement or




2 Transfer data to and from range charts along the 77-F wb line

## Charts combine simplicity, accuracy and flexibility in one package




3 Interpolate answers from charts straddling ranges not shown

design of tower prevent accurate comparison of tests before and after alterations. And very high or low flow rates affect water distribution so much that they act as a design change. If a change is made, though, charts can still apply. Just use the first test after the change as the start of a new series of tests.

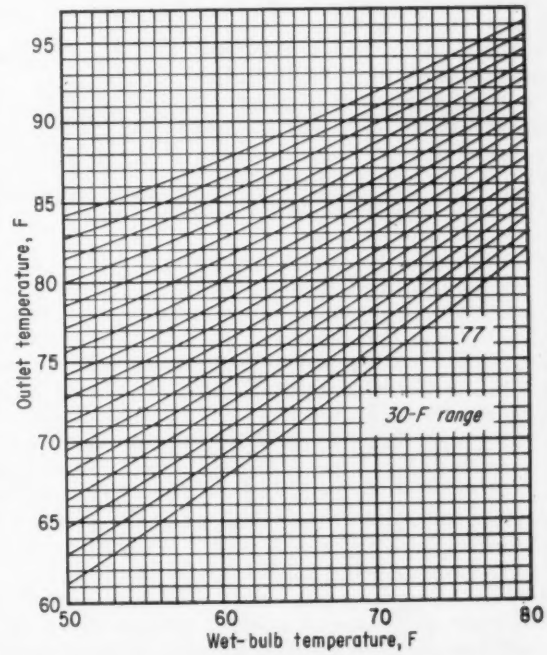
**Any cooling-tower make** is covered by charts. Cooling ability of tower can be stated mathematically, using five variables. Three of these form a constant that's good for any particular tower; altering tower changes the constant, invalidating tests made before the change. Changing load conditions other than extreme flow rates affects accuracy very little.

Now let's look at the charts. In most problems you will have to transfer values between Fig. 2 through 4 and Fig. 1. To make transfer, locate outlet temperature values on the 77-F wb lines of all range charts (10, 20 and 30) before moving on to Fig. 1. Do the same coming back; always enter range charts along 77-F wb lines.

In using the charts you'll find there is no apparent way to work with any range other than 10, 20 or 30 F. If you have a different range value, say 28 F, simply work the problem twice, once in the range chart on each side of your cooling range. With a 28-F range work your problems once with the 20-F and once with the 30-F charts. After getting the two solutions, use straight-line interpolation to come up with your answer.

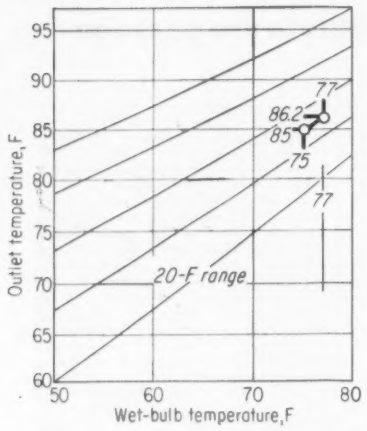
After getting used to the charts, try working out a problem for the 28-F range, but use only the 30-F chart. The error will be small, particularly when the wet-bulb temperature is 70 F or higher.

**continued**

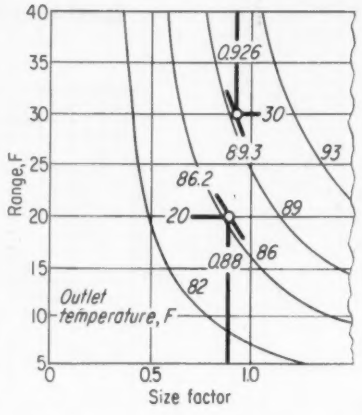



4 To predict changes in wb temperature use only the range chart

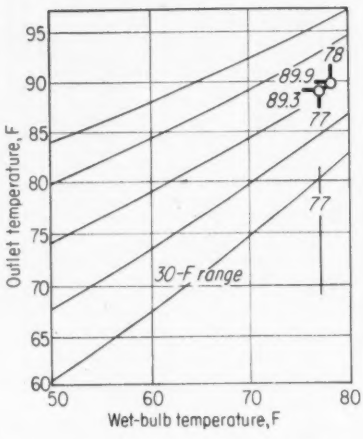
## Sample problem, Part No. 1: Does tower meet design guarantee?




**5** Follow curve from 85-F outlet at 75-F wb to 86.2-F outlet at 77-F wb




**6** Change in range, size factor leads to a new 77-F wb outlet of 89.3 F




**7** Use 30-F chart to reach final answer of 89.9-F outlet at 78-F wb

Going through an example will help explain how the charts work. Given: Tower is guaranteed to cool 10,000 gpm of water from 118 to 88 F at 78-F wb. Test shows tower actually cools 9500 gpm from 105 to 85 F at 75-F wb. Question: Does tower meet guarantee? Procedure: Start with actual operating data and work toward design values. First locate the outlet-temperature transfer point on the 20-F chart (86.2 F, Fig. 5). Use this value and 20-F range to find the size factor (0.88, Fig. 6).

Since actual flow figure is changed to meet the design value, the size factor must be changed proportionally (10,000/9500x0.88 or 0.926). Combine this figure and design range (30 F) to pick second outlet-temperature transfer value and go on to Fig. 7. Here we find the actual outlet-water temperature for design range and wb temperature is 89.9 F. So charts say the lowest outlet temperature the tower will produce for 30-F cooling range, 10,000-gpm flow and 78-F wb temperature is *not* 88 F.

**Part No. 2:** How much is tower off? Start with design values (Fig. 8). Transfer to Fig. 9 and find size factor (0.77). This is factor needed to meet guarantee data. Since this is smaller than the actual size factor, the tower should be 100(0.926/0.77) or 1.2 times the present size.

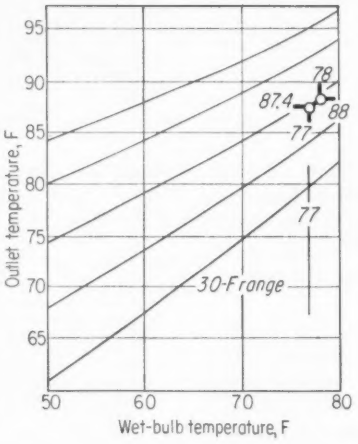
This 2-part example covers a problem that contains three simultaneous changes—wet bulb, range and flow. Let's go over the problem again and change only one value at a time.

(a) Change in wet bulb only (75 to 78 F). Locate operating data on Fig. 3 (85-F outlet, 75-F wb, 20-F range). Then follow curve up to 78-F wb line, read new outlet: 87.0 F. For 72-F wb outlet is 83.1 F.

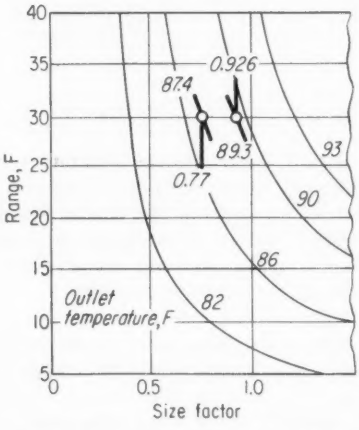
(b) Change in range only (20 to 30 F). Follow steps for Fig. 5 and 6 in above example up to location of 0.88 size factor. Go up this line (use Fig. 1 for accuracy) to 30-F range and read outlet temperature of 88.9 F. Transfer this value to Fig. 4. Enter at 77-F wb, run down curve to 75-F wb and read 87.9 F—the new outlet.

(c) Change in water flow rate only (9500 to 10,000 gpm). Again follow steps for Fig. 5 and 6, this time to second size factor, 0.926. Using Fig. 1 follow this line to 20-F range, read 86.6-F outlet value. Now use Fig. 3, entering at 77-F wb; drop to 75-F wb and read final outlet temperature of 85.3 F, the result of changing flow rate only.

## Part No. 2: How much is tower off?




**8** Transfer 87.4 outlet (at 77-F wb) to Fig. 9, get design size factor

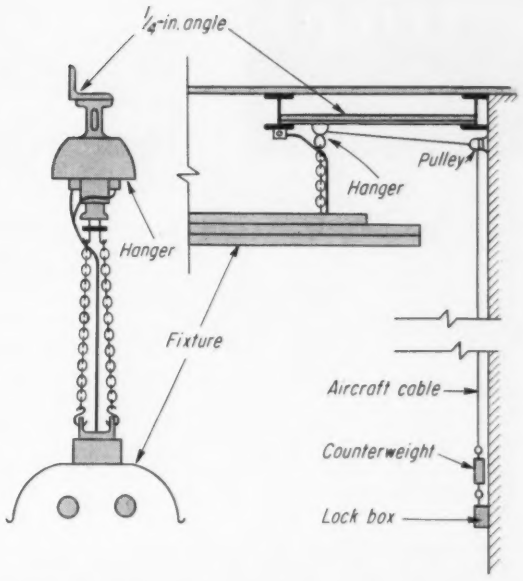



**9** Size factor ratio, operating over design, shows tower size increase needed

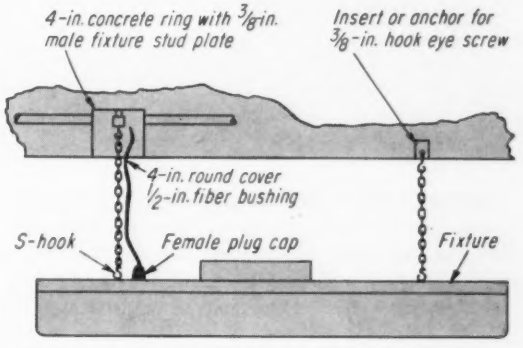
# Installing new fluorescent lamps? Follow these tips

**Mounting and maintenance problems can be simplified if you start out with the scheme most suited to the construction of your plant**

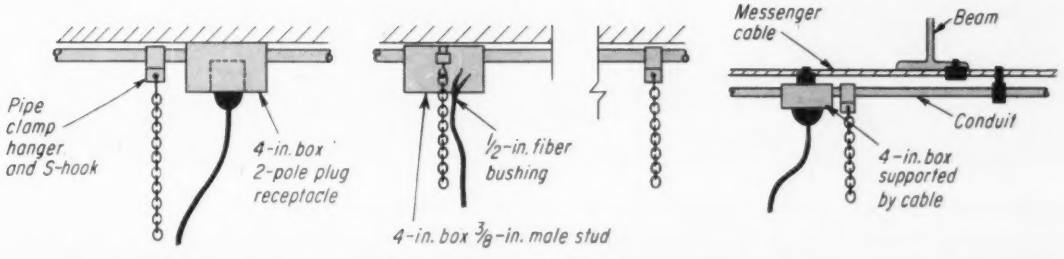
By WALLACE M ADACHE, Consulting Engineer
Adache Associates, Inc, Cleveland, Ohio




**LOWERING HANGERS** makes fixture cleaning and lamp replacement easy. Hand line for lowering fixture is stored in lock box


4-in. concrete ring with 3/8-in. male fixture stud plate
Insert or anchor for 3/8-in. hook eye screw
4-in. round cover 1/2-in. fiber bushing
S-hook
Female plug cap
Fixture

**CONCRETE CEILING** with embedded conduit can support fixture by stud plate in outlet box and an anchor for chain at other end




**MOUNTING ON CONDUIT** can be accomplished in three ways. Pipe clamps and S-hooks can be used, with plug receptacle on ceiling, *left*, or fixture stud in ceiling-mounted outlet with plug receptacle on fixture, *center*. Or support conduit by messenger

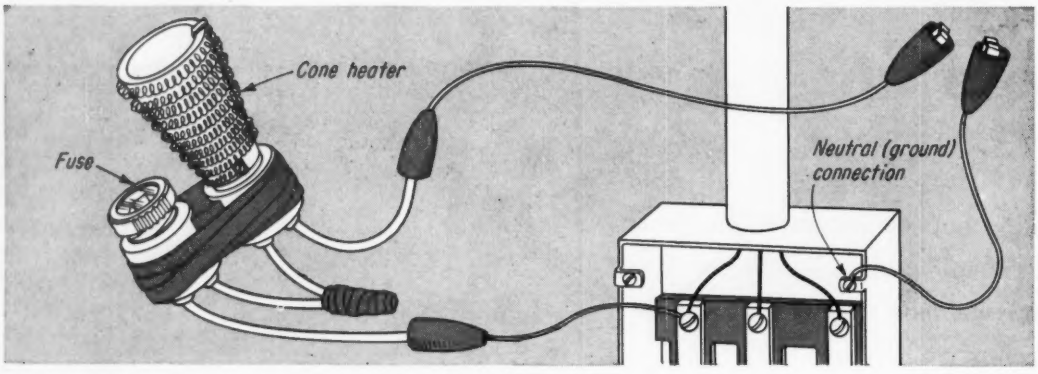
Plant Electrical Fact File

NO. 35: TEST EQUIPMENT

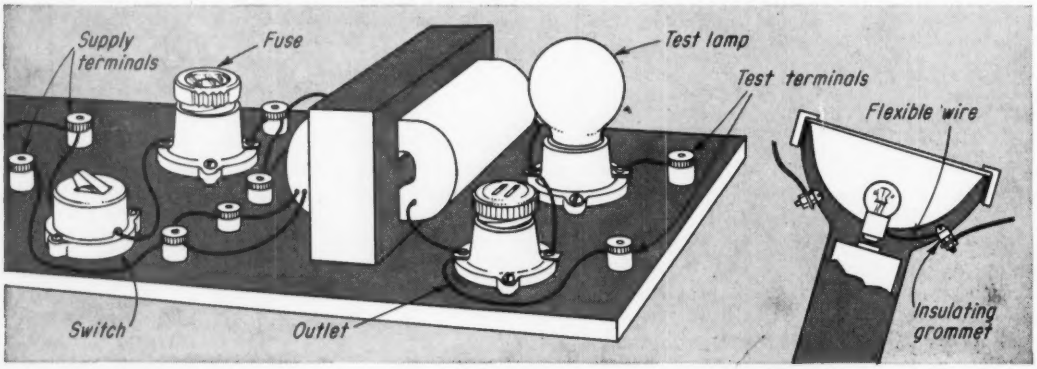
# 5 hints on trouble-shooting test equipment

By NORMAN PEACH, Associate Editor

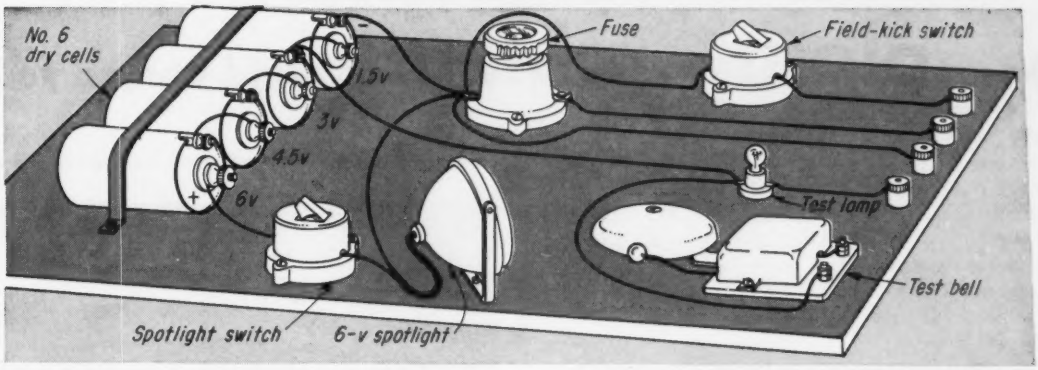
Every trouble shooter has his favorite test getups that help him pinpoint trouble. Here are five ideas recommended by electrical maintenance men. This equipment is easily made from ordinary shop supplies and will quickly repay the time spent in putting it together. Perhaps you have some ideas of your own that will make improvements on the setups shown. Since many of today's plants have some dc equipment, the test set (3) may prove helpful.



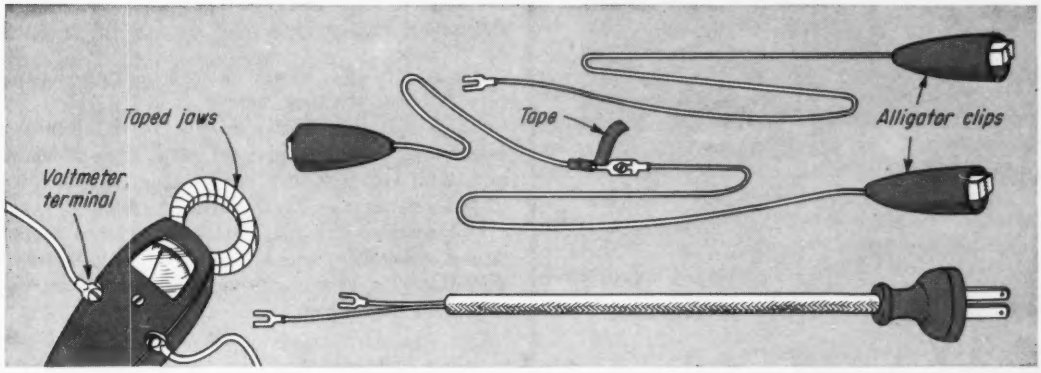

**VERSATILE TEST LAMP** is made of two pigtail sockets in series. They're taped together, but spaced so it's easy to screw in different devices. With two small lamps it's easy to distinguish between 220, 120 or 440 volts. Large lamp or cone heater in series with fuse acts as "current limiter" for test supply voltage, useful in checking relays, etc. It can also be used as emergency convenience outlet for small tools or a spotlight. Keep leads short; clip on extensions if needed to reach the test point.



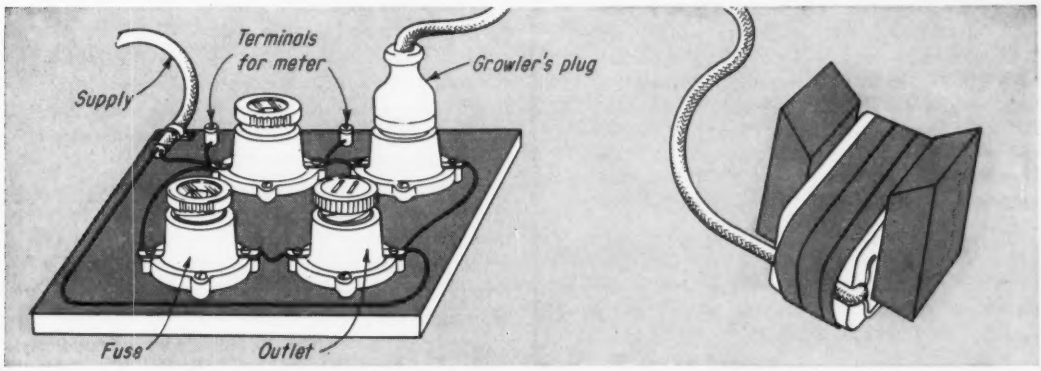

**2 CONTINUITY TESTERS** should have power source isolated from circuits being tested. This is accomplished by insulated transformer. Setup shown has double-winding primary for use on 220 or 440 volts. Test voltage is 120. If you include convenience oulet be sure transformer has adequate capacity. If you provide screw terminals for all connections, on-the-spot changes are easy. Many trouble shooters swear by the flashlight as a continuity tester; screw terminals are easily installed.




**3 SPECIAL TEST SET** uses No. 6 cells as power source. As each cell is about 1.5 volts, tapped series combinations can be made up as shown. The flashlight bulb is good for detecting low resistances; change of ½ ohm causes noticeable flicker. Switch is useful for inductive-kick method for setting dc brush-holder position. Door bell is alternative to lamp where convenient, but may not work satisfactorily on high-inductance circuit. A 6-volt spotlight can be mounted on adjustable-height stand.

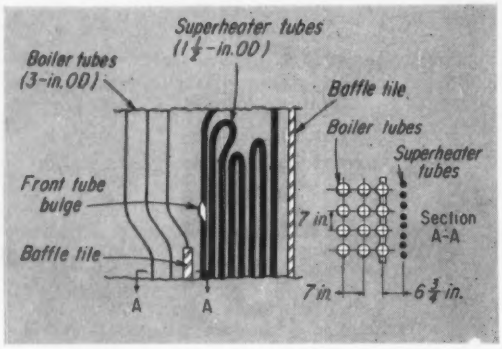



**4 TEST LEADS** of various lengths and wire sizes should be on hand for jumpers, temporary connections etc. Best arrangement has an alligator clip on one end, open-slot terminal lug on the other. Pairs can be joined when needed. If lugs fit instrument terminals they will be handy for rough measurements (accurate measurements require calibrated leads). Clamp ammeter, shown, has jaws covered with plastic tape to prevent shorting live terminals. Plug cord has leads staggered at the opposite end.




**5 GROWLER AND TEST BOARD** is handy for checking dc armatures for shorts and ac rotors for open circuits (see *Fact File* No. 23, March 1958). Fuse can be replaced by lamp in series, or voltmeter can be connected across empty fuse holder. Growler can be purchased or built from old transformer core. Two sizes may be convenient if you have a large range of motors and armatures. Test board can be fitted out as a "distribution center" for convenience outlets for small electric tools, lights.

# These **plant problems** could well be yours...

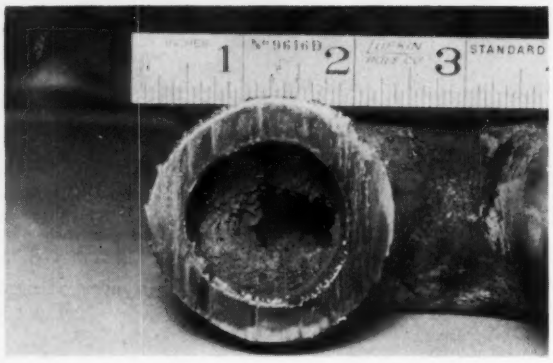



## The problem

## What caused superheater failure?

Recently we had superheater failures in two identical 600-psi, 750-F, oil- and gas-fired steam generators supplying steam for process and turbine-generators. Boilers have been in service about four years. Only failure in the first unit was an egg-like bulge with cracks parallel to tube at thinned areas of the bulge. Five superheater tubes in the second unit failed the same way. In each case, bulges appeared on furnace side of the tube within two feet of first baffle as shown above. Inspection of four sectioned tubes showed no metal loss, just general thinning in the bulge. There doesn't seem to be any pattern of failure. Only two of the five failures in the second unit were adjacent in the bank of 36 tubes. Two years ago the superheater tubes were washed to remove a severe accumulation of scale. But inspection failed to show any swelled tubes. What can we do to prevent a recurrence of these failures?—*CCB, January* POWER

## The solutions




### Plugged tubes are one cause of failure

There are probably several reasons for these superheater tube failures. My first thought, and I'm going to stick to it, is that the failures are the result of tube metal overheating caused by plugged tubes. Scale accumulation in a 2-in. OD x 0.22-in. thick reheat superheater tube loop, above, gave us almost identical trouble.

*CCB*'s boilers are four years old and two years have passed since they were washed to remove severe scale accumulations. It seems to me that it's time to wash or acid-clean them again.

M J MOSELEY, *Paducah, Ky.*

### Water in superheater is another cause

*CCB*'s troubles apparently stem from one source—water in the superheater tubes. The very number of failures only emphasizes the cause. Superheaters tend to trap water during cooling-off period when boiler comes off the line. Since it's impossible to drain all water from the tubes, great care must be taken to follow correct startup procedure. Required flow of steam is not established when water is present. Inadequate steam flow subjects the tubes to excessive temperatures. So it's extremely important to use slow firing rates until all accumulated water is evaporated and steam flow established.

During startup the drum and superheater drains should be wide open and a slow or even intermittent fire employed to keep tube-wall temperatures down within safe limits while any entrapped water is being evaporated. Close the drum drain when steam pressure reaches 25 psig but keep the superheater drain open. It may be throttled to maintain enough steam flow to rid header of condensate but don't close it until boiler is on the line. Careful attention to manufacturer's operating instructions for your boiler should eliminate or drastically reduce tube failures from entrapped water.

W A PAGE, *Old Chatham, N.Y.*

# ...Here's how *Power* readers would tackle them

BOB MARKS, Associate Editor

## Carefully check steam washer for leaks

Superheater tube failures reported by *CCB* were undoubtedly caused by carryover from the steam drum to the superheater outlet header. Solids entrained in the carryover "fried" out on the tube surface at point of heat input to the tubes. This buildup of scale insulates metal from steam, resulting in overheating of the metal and consequent bulge and cracks.

Steam is supplied to superheater inlet header by several nozzles from the steam drum. Carryover from the drum enters superheater tubes at point where steam supply enters the inlet header. So it's a safe bet that superheater tubes which failed are opposite or close by saturated-steam inlets to superheater inlet header.

Carryover has many causes, but don't overlook the fact that leaks in the drum internals (steam washers) can pass boiler water through to the superheater. Usually these various sections are bolted together with gaskets between flanges. Since these gaskets deteriorate, best solution is to remove them, bolt the sections together again and seal-weld all joints.

R J MARTIN, *Elizabethton, Tenn.*

## We had series of similar tube ruptures

Recently we had a series of superheater failures similar to *CCB*'s. Tubes bulged and then ruptured. These failures were caused by improper grain structure in the tube metal. After a period of time the metal began to creep and ultimately rupture occurred. The fact that *CCB* had severe scale accumulation in his superheater tubes suggests that tube metal may have been overheated at the time, causing a change in metal structure. Failures are in the area of highest gas temperature. So presence of scale would have produced high tube-metal temperature. *CCB* should consider taking tube measurements periodically to check for swelling. If this is happening, part of the superheater may have to be retubed. This had to be done in our case.

J L RUSS, *Alexandria, Va.*

## Improved water treatment is called for

Superheater failures may be caused by (1) overheating of superheater elements from scale deposits that act to reduce heat transmission (2) too much radiant heat on exposed superheater tubes from improper baffling or faulty flame conditions and (3) tube metal not being able to withstand operating pressure and temperature.

Scaling conditions can be controlled by improved external and internal water treatment. Close operator attention is also called for to prevent any carryover. Any deposits on the superheater tubes restrict heat transmission and raise metal temperature to points exceeding upper limits of tube metallurgy.

If there is too much radiant and not enough convective heat in front sections of superheater, the baffle can be extended and burners adjusted to bring fire center away from the superheater elements. But first make sure that every possible step is taken to prevent carryover. If all else fails then give consideration to improving tube metallurgy. This can be done by welding-in sections of tubes across superheater's entire face from a point about 1 ft below baffle to 4 or 5 ft above.

A T RAGAN, *Port Lavaca, Texas*

## Put thermocouples on superheater tubes

Local overheating is the probable cause of these superheater troubles, particularly since they occur in the area just above the baffle wall. This can be investigated by sending a section of the bulged area for metallurgical examination of grain structure, or by fitting thermocouples to tube walls. Superheater tubes can easily overheat when raising steam. Watch superheat temperatures closely and maintain adequate circulation through the superheaters at all times.

R F HAWKINS, *Montreal, Canada*

## Keep boiler-water solids under control

Superheater failures in boilers that have operated four years without superheater trouble point strongly to a carryover problem. If it were a case of poor boiler design the trouble would have developed early and repeated itself a number of times over this 4-year period. Failure from carryover usually develops near the inlet end as shown on sketch. Any solids that carry over interfere with heat transfer and eventually cause tube failure.

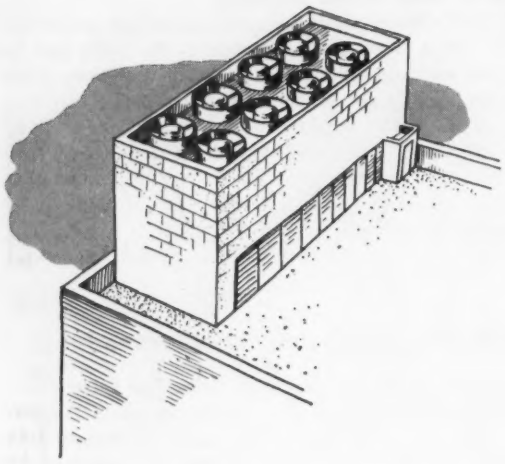
Examine boiler-water analysis records for excessively high total dissolved solids and alkalinity. ABAI maximum allowable solids concentration for boilers operating at 600 psig is 2000 ppm. If concentrations are carried higher than this the probability of carryover taking place is greatly increased. Good operation calls for staying well under the recommended limits. It's extremely important to check continuous blowdown carefully on at least a daily basis. Make sure that blowdown is taken from point of maximum concentration in the drum.

It's difficult to diagnose trouble without being able to ask pertinent questions as they arise. Why not call on the boiler manufacturer's engineers for help? Follow this up by bringing in a feedwater-treatment consultant.

N ROHRHURST, *Bound Brook, N. J.*

Turn page for new problems ▶

# More **plant problems**



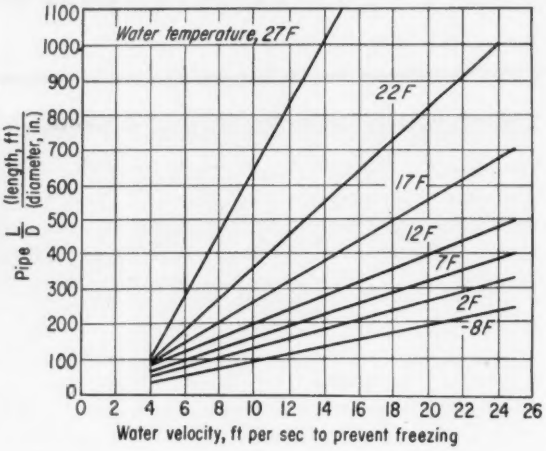
## The problem

## How can we protect cooling tower and piping from freezing damage?

We operate a 400-ton refrigeration plant in a large, sprawling 2-story building. Internal heat load is such that the plant must be run in subfreezing weather. The chilled-water circulating system supplies water to individual air-handling units located throughout the building. What precautions should we take to keep the chilled-water pipe and coils from freezing during shutdown periods at night and over week ends? When internal heat load is low the same problem arises with the condenser-water circuit. Water circulates from machine room in the basement to cooling tower on roof. Pipe shaft is located in building. What is the best method of protection?—*JF, January* POWER

**Want some help on plant problems? Send us any of your design and operating headaches. We'll put *Power* readers to work on them**

## The solutions




### Continuous recirculation is one answer

*JF* doesn't give room and ambient temperature during evening and week-end shutdowns. When the temperature is –8 F, it takes 24 hours to freeze still water solid in a pipe without insulation. But flowing water will not freeze except at extremely low temperatures. Tests on a water line at 32 F without insulation show that four feet per sec velocity is enough to keep the water from freezing. Curves, above, give minimum flow needed to prevent freezing at various water temperatures and pipeline sizes.

H B WAYNE, *Woodhaven, N.Y.*

### Put antifreeze in chilled-water system

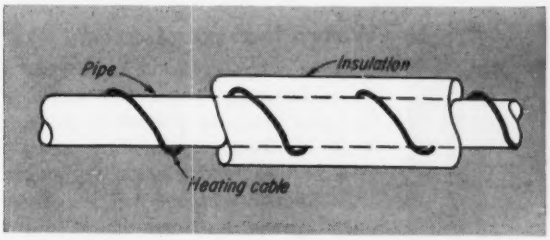
The chilled-water system can be protected from freezeups by circulating the water and adding heat during any shutdown. Both circulating pump and heat exchanger can be controlled by a thermostat. Another method is adding a permanent type antifreeze. This is economically feasible when the system isn't too large. But system must be tight and the circulating pumps equipped with mechanical seals. Cost of installing a heat exchanger should be weighed against the cost of the antifreeze. A 20% solution of ethylene glycol will give you adequate protection at temperatures down to 15 F.

W R MAY, *Pittsburgh, Pa.*

### Why not use well water for cooling?

There are several ways of protecting towers and condenser water against freezing. You can use a bypass on the tower and heat the lines, pan and machine room. But all these methods need operator attention and so are not infallible. Positive protection is yours if you can use well water for condenser cooling. Then at certain times of the year it may even be possible to get enough cooling without running the refrigeration machines.

F J DUFFY, *Valley Stream, N.Y.*




## Consider the use of heating cable

Flexible lead-covered heating cable, above, has been used successfully for protecting pipes, valves and pumps from freezing; warming pipelines that transport viscous materials; freeing sidewalks, driveways, etc from ice; melting snow from eaves and downspouts; floor heating and miscellaneous air heating.

One manufacturer recommends heating cable on the basis of about 0.8 watts per sq ft of uninsulated surface per deg F temperature difference wanted between surface to be protected and the surrounding still air. If the surface has about one inch of insulation, use about 25% of this value. Table, below, gives lengths of cable recommended for the more common voltages.

| Length in feet | Volts | Total watts |
|---|---|---|
| 30 | 110 | 180 |
| 60 | 110 | 400 |
| 120 | 220 | 800 |
| 240 | 440 | 1600 |

D W ANTONACCI, *Warrington, Fla.*

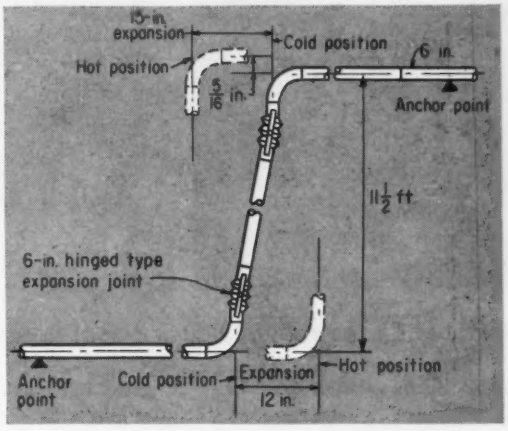
## Make full use of automatic controls

*JF* should not worry about the chilled-water lines freezing unless they are exposed to atmosphere. But danger of freezeup with the cooling coils is very real. If *JF* has economizer control the outside air is used for refrigeration. To satisfy heavy internal load in subfreezing weather, fresh-air dampers will open to the maximum position. When only a minimum amount of fresh air is heated, it must be thoroughly mixed with return air to reach desired temperature. Any stratification in the casing, malfunctioning controls or faulty dampers can direct enough cold air on the cooling coils to freeze them. So it's a good idea to extend preheat coil across full length of the casing. A thermostat will hold temperature at 40 to 45 F in space between preheat and cooling coils. If some chilled-water piping is exposed to atmosphere keep the pumps running during shutdown. It may be necessary to put a heat exchanger on this line.

Next, install an automatic bypass around the cooling tower to control temperature of water in the condenser circuit. Then put a steam coil in the cooling-tower pan, actuated by a thermostat in the water or outside air. It's also possible to install automatic fresh-air louvers in the tower to adjust temperature of the leaving water—this feature may be enough without installing a bypass. In some cases it's necessary to use all three in automatic sequence. Heating coils, louvers and bypass then come into action as they are needed.

G POLIMEROS, *Brooklyn, N.Y.*

## Your April problems




## What factors are most important in selecting expansion joints?

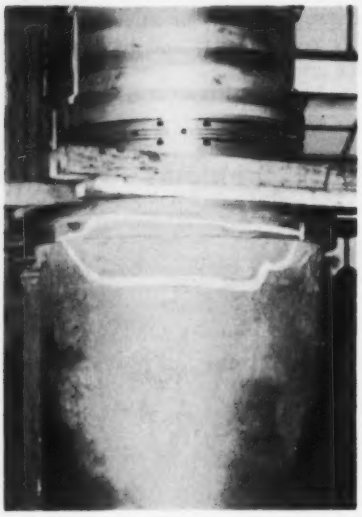
Our plant uses a hinged type expansion joint, above. This is in service on a 275-psig, 500-F total temperature steam-distribution system. Present plant calls for modernizing and expanding our facilities. Will it pay to standardize on this or any one type of expansion joint? What other designs are suitable? In choosing expansion joints, what are factors to consider?—*DWA*

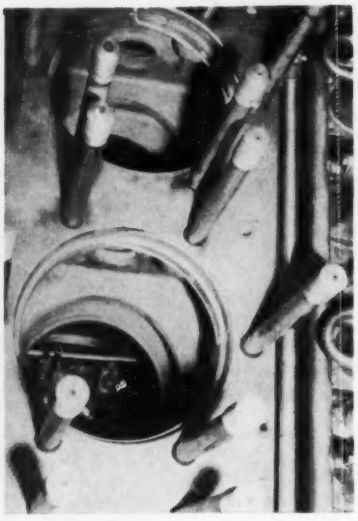
## What's the best way to clean and maintain unit heaters?

Our plant has a great many horizontal and downflow unit heaters operating on low-pressure steam. Much of this equipment is well over 20 years old and to my knowledge has never been cleaned. The radiators are full of lint, dirt and grease. Needless to say efficiency has dropped considerably. We tried cleaning them with compressed air and brushes but this wasn't too successful. There wasn't enough time available during our last summer shutdown to do much work on the unit heaters. With the help available we were just about able to complete overhauling the rest of the heating system. Steam cleaning has been considered, but this isn't practical for the large office and cafeteria spaces. What is the best way to clean unit heaters and keep them operating at top efficiency? Any suggestions from POWER readers will be greatly appreciated.—*RMM*

**Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches**

# Timely **practical ideas** to help solve





## Plastic steel saves $100,000 in diesel repairs on one job

A Cuban power station was faced with a shutdown to repair one of its 8-cylinder diesel engines. Corrosion had eaten away a section of the wet sleeve of each cylinder, photo, as well as part of the block. If possible, replacement had to be avoided, because it would cost $900 for each new sleeve, or over $100,000 to replace the complete block.

Welding seemed the logical solution. But since there were no weldors on the island, the company would have had to send to Miami and pay a weldor's round-trip transportation, full living expenses, plus a wage rate of $8.00 per hour. Since welding cast steel is a slow and difficult process, estimated time for job was one week.

The company decided to try a plastic steel made of 80% steel and 20% plastics. This compound hardens to steel-like strength two hours after mixing with the hardening agent. No heat, pressure or special skill is needed. It has a high bonding ability with cast iron, steel, bronze, brass, aluminum and other metals.

Eight sleeves were removed and, with the corroded block, were cleaned thoroughly. Plastic steel, types A and B, were applied and allowed to harden. Surface was then ground to exact tolerance and units were reassembled and put back into operation. Two pounds of plastic steel A and one pound of plastic steel B were used. Total cost of material: under $10.00. Total working time: 8 hours.—*Courtesy, Devon Corp, Danvers, Mass.*

## Watch that caustic soda

We have a 125,000 lb per hr Sterling underfeed stoker boiler that carries the plant at about 100,000 lb steam per hr. Condensate returned from all parts of the plant amounts to about 50%. About 10 am one day, a safety valve blew on the boiler. The water-column alarm sounded simultaneously. I left the office on the double to investigate and found:

(1) Steam load was about 135,000 lb per hr on the recorder. (2) Feedwater flow recorder showed below normal input. (3) Gage glasses were useless due to surging and foaming condition. (4) Steam pressure was 208 psi; normal is 200 psi.

Realizing chemicals had entered the boiler I had the returns discharged to the sewer while operating on 100% makeup. The high reading on the steam flow recorder indicated water in the steam going through the orifice. That caused the excessively high reading. I knew the boiler was safe as long as the steam flow registered more than 100,000 lb per hr. Using this as a guide we operated blowdowns and increased the feedwater to dilute the boiler water. After about two hours the foaming and surging stopped, making it possible to lower the water level to normal. We finally opened the boiler for checking, but found it in good shape.

Culprit was a barrel of caustic soda which was accidentally allowed to enter the return lines.

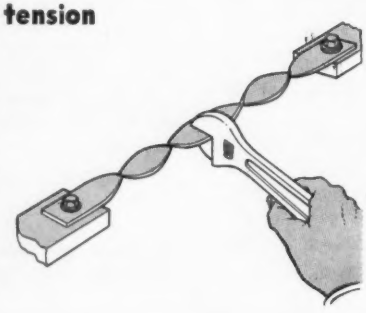
In a chemical plant there is no substitute for good metering and recording of services and flows. Here, house turbines are used, but no turbine-generators that might be damaged with super wet steam.

L W Livingston, *Bound Brook, N. J.*

## Band iron gives you plenty of tension

Every mechanic finds a need for a tensioning device or a turnbuckle substitute. We found that a length of band iron fits the bill.

Most shops have various sizes around. We secure the ends by bolting, sketch. Then, by twisting the band with a large monkey or crescent wrench, we can develop a devilish tension. H Koslow, *Bronx, N. Y.*



## Here's how . . .

to get a straight cut when cutting pipe with a hacksaw. Just wrap a piece of paper having a straight edge around the pipe and tape it on. By following the paper's edge, you'll get a straight cut. You can also use this idea when cutting curved piping.

W J Ary, *Seattle, Wash.*

# your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

## It isn't easy . . .

to determine if polished steel is mild, tool steel or stainless simply by looking at it. After you weld on a stainless overlay you should grind off the welding beads and polish to obtain a smooth finish. But there's always the danger of cutting through the thin overlay of stainless, allowing corrosive action, pitting, etc to start. This defeats the purpose of the overlay which is, of course, to protect the mild-steel surface from these evils.

We have run into this when laying stainless on cavitated areas of turbine runners. To determine if we have cut through the stainless overlay, we use a solution of copper sulfate, $CUSO_4$, known as "blue vitrol." This solution turns mild steel a brownish color, but doesn't affect the color of stainless. Trouble is quickly spotted. L McWILLIAMS, *Shawinigan S, Que.*

## V-belt size at a glance

Here's how we measure V-belt drives to see what length belt is needed. We made up several pieces of V-belt with a cloth tape cemented to the back, as shown in sketch. These are made with both A and B belts. To measure for a belt size we select the A or B gage belt and wrap it around as shown. The tape reads directly in inches of outside belt length.

You must position tape correctly on the belt, but this is an easy job. Just place zero end of tape at end of the belt. The section of the tape with low numbers can then be discarded.

Try this method next time you are sizing belt for your V drives.

W MARTIN, *Brooklyn, N. Y.*

## What would you have done?

A rag got stuck in the gears of our old belt-driven Lombard governor one night. Naturally the flyballs stopped, both needle nozzles went wide open and I had lots of kilowatts. But this condition didn't swing the system speed enough to bother even the load dispatcher.

Our hydro plant had about 1000 ft head, with three penstocks leaving the surge chamber. She split into pairs about halfway down the hill. There were four units of about 36,000-kw capacity on two penstocks and one 25,000-kw unit on the third, with a pipe going to each wheel. Because none of them had overspeed shutdown devices (automatic devices like modern governors) the immediate situation called for some discretion on my part.

I took a quick look at the kw meter. She indicated about 12 mw on the unit. I breathed my story over the carrier current phone to the dispatcher's attentive ear. Being a man of few words he immediately barked back his instructions. "Get rid of it," he roared. And he didn't have to tell me not to break any penstocks.

Each penstock from the surge chamber split at an inverted Y about halfway up the hill from the plant, so I had something to work on. By juggling the load on the other unit paired on the same pipe, I was soon able to report to the floorman, "I've got this unit floating at about 1000 kw, so stand by that stuck governor. When I give a chopping signal with my right hand, close the emergency shutdown device."

When the floorman got in position to close the shutdown device, I gave the chopping motion with my right hand. He gave a lusty pull on the governor control of the floating unit. Everything worked like a charm. Whatever potential surge of water hammer might have started went up to the Y and down the other pipe. We hardly made a ripple on the recording pressure gage. The units were limited to about 9 mw because of water when the plant was loaded, so under these circumstances we could squeeze out about 12 mw. If faced with the same situation, what would *you* have done?

E G EVANS, *Adak, Alaska*

## Home on the range?

One of the most useful things you can have in your plant shop is an electric range with a good oven and good controls. For many jobs such as heating a flange to slip on a shaft, heating a bearing, preheating before welding or gradually cooling after welding, it comes in real handy. And it just happens that an electric range can even be used for making coffee. You'll get back the purchase price of a used range many times from the time-saving uses you'll find for it.

S H KRONE, *Jamestown, N. D.*

# More **practical ideas**

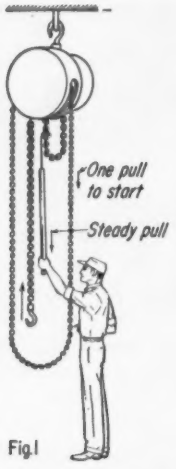


Fig.1

Fig.2

Fig.3

## Here's your chain trick of the month

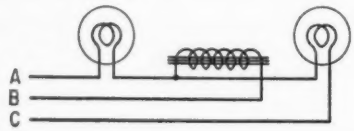
We use many hand-powered chain hoists for maintenance and other lifting jobs, and often have to raise the hook without load on it. It takes a lot of hauling on the chain to raise the hook, especially on larger hoists which have a high ratio.

To speed up this operation, we use a length of ⅜-in. stock with a light hook on the end, Fig. 1. The hook is long enough to permit reaching up to attach it as shown. To raise the main hook we attach the light hook and line to the load chain, so a light tension on this line and a single pull on hand chain causes chain to run. Load hook can be raised to any height without touching hand chain again.

Like many shops we use a chain hoist to lift barrels of scrap onto trucks. The conventional hoist is arranged as in Fig. 2. But we found we were wasting time with this setup. After lifting a barrel, it took too much time to lower the hook to pick up the next barrel.

To speed up this work we cut the chain, Fig. 2, and added a second hook assembly. (Instead of cutting the chain, a second length of chain can be added as shown in Fig. 3.) Now after we lift one barrel the second hook is in position to lift the next barrel. Thus we save time formerly spent lowering the empty hook.

H KOSLOW, *Bronx, N. Y.*




## Need a good phase sequence indicator?

I found Norm Peach's *Fact File* No. 29, Sept 1958, POWER, pp 116-117, "Tips on testing phase sequence" most interesting. Here's a phase-sequence indicator I made and one that anyone can make, sketch. Take any 220-v coil on an iron core (mine is an old coil from a single-phase power motor), two porcelain flush-mounting lamp receptacles, two 220-v 25-w lamps, three identified leads with clips, and mount them on a 2x4, about 8 in. long. Usually, phase sequence is a matter of comparison only. But you must know the actual sequence at times. Unbalanced 3-phase currents are very involved.

E G GARDINER, *Red Deer, Alberta*

## My biggest boner

I was chief in a small chemical processing plant. We had a 400-psi electric boiler, which used sodium sulfite as an electrolyte. Plant was short a man, so a new engineer and I worked 12 on and 12 off. Shortly after I turned the watch over he started having trouble. Because the boiler wouldn't get feedwater he had to keep shutting down. Being an old coal-burning fireman, he called in the maintenance man. They took off the pump governor and assumed a pinhole in the rubber diaphragm was causing the trouble. So they cut another diaphragm. By then everyone from the superintendent and plant engineer to the helpers were working on the boiler.

After starting up with the new governor diaphragm the boiler still wouldn't take water. They gave up. An hour later I came on watch and threw the switch. Pump still wouldn't feed the boiler, so I adjusted the pump governor spring. The boiler filled up and started generating steam. The superintendent asked me how I solved the problem after it had all the brains scratching their heads.

I told him the new diaphragm was a different composition, 4-ply instead of 2-ply rubber, making a big difference on tension. The super congratulated me, but the maintenance man claimed that: (1) I had "rigged" the deal in an effort to show the boss what a good man I was and (2) I planned the job to go haywire on the other guy's watch so I could walk in and fix it after drawing a crowd. He never admitted he was in error for not coming up with the answer to the problem. Moral of this story: If someone can't get a thing fixed, wait until he is completely through before fixing it yourself. To this day the maintenance man has a lot of people believing that I rigged the job.

T MULLIN, *Seattle, Wash.*

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*PUMP:* Mfg. by Buffalo Pump Co. — vertical single stage — capacity 550 GPM — 30# discharge — 8" suction — 5" discharge. *TURBINE:* 1 stage impulse — type Y-W — vertical — design steam pressure 575# — back pressure 20# — 12.5 HP — 5500/1750 RPM — mfg by Terry Steam Turbine Co.

### 2 MAIN FEED BOOSTER PUMPS

Same as geared turbine driven main feed booster pumps above, but with 14.5 HP 440/3/60 AC Star motor & Ward Leonard control. Across-the-line starter with pushbutton.

### 8 GEARED TURBINE-DRIVEN VERTICAL CONDENSATE PUMPS

*PUMP:* Main condensate 2-stage vertical pump — mfg by Buffalo Pump Co. *Capacity:* 375 GPM — 70#/sq. inch discharge pressure — 1150 RPM — 22.5 BHP — 9" suction — 4" discharge. *TURBINE:* Single stage — 575# working pressure — 20#/sq. inch back pressure — 22.5 HP — 5360/1150 RPM — Mfg. by Terry Turbine Co.

### 2 AUX. FEED BOOSTER PUMPS

*PUMP:* Vertical — mfg by Buffalo Pump Co. — 200 GPM — 30# discharge pressure. *MOTOR:* 7.36 HP — 1800 RPM — 440/3/60 — Star motor, with control.

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11 x 8 x 18 — mfg by M. T. Davidson Co. — vertical simplex — capacity 180 GPM — 800/900# discharge pressure — 575# working pressure.

### 4 TURBINE-DRIVEN FIRE AND FLUSHING SERVICE PUMPS

*PUMP:* Worthington — horizontal centrifugal. *Fire Service:* 750 GPM capacity — 150 PSI discharge pressure — 3500 RPM. *TURBINE:* single impulse — type B-20 — mfg by B. F. Sturtevant — design steam pressure 575# per sq. inch non-condensing. Back pressure 15# — B.H.P. 80/90.

### 3 GEARED TURBINE-DRIVEN MAIN CIRCULATING PUMPS

*PUMP:* Mfg. by Worthington Pump & Machinery Co. — 28" type — vertical single stage — bronze. *Capacity:* 28,000 GPM — discharge pressure 13.5# — 600 RPM — 267 BHP — 28" suction — 28" discharge — 8.5:1 gear ratio. *TURBINE:* single impulse — vertical type — 575# design steam pressure non-condensing — back pressure 15#/sq. inch. RPM 5100 pinion — 600 gear. Reduction gear ratio 8.5:1 — 267 BHP — mfg by B. F. Sturtevant.

### 3 MOTOR DRIVEN MAIN CONDENSATE PUMPS

Mfg. by Buffalo Pump Co. — vertical 2-stage — 375 GPM — 70#/sq. inch discharge pressure — 1150 RPM. *Motor Data:* 25 HP — 440/3/60 — 1150 RPM — Star Electric Motor Co. — with across-the-line starter, with pushbutton station — mfg by Ward Leonard.

### 8 GEARED TURBINE-DRIVEN MAIN LUBE OIL PUMPS

Mfg. by Northern Pump Co. *PUMP:* Vertical rotary type — 750 GPM — 55#/sq. inch discharge pressure — 263 RPM — 35 BHP — oil viscosity 130 to 500 S.S.U. — 7" suction — 6" discharge. *TURBINE:* Single stage — 575# design pressure non-condensing — exhaust pressure 15# — 35 BHP — 26.39:1 gear ratio — 6940 RPM.

### 4 TURBINE-DRIVEN GEARED FUEL OIL BOOSTER PUMPS

Mfg. by Northern Pump Co. — vertical rotary — 300 GPM — 150# discharge pressure — 282 RPM — 47.3 BHP — Oil viscosity 70-700 S.S.U. — 7" suction — 5" discharge. *DRIVE:* single stage impulse — 575# non-condensing — 15#/sq. inch discharge pressure.

### 6 FUEL OIL SERVICE PUMPS

Mfg. by Northern Pump Co. — vertical rotary — 85 GPM — 350# discharge pressure — 560 RPM — 27.4 BHP. *TURBINE:* 1 stage — 575# non-condensing — exhaust pressure 15# — mfg. by Northern.

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#### 2 HIGH PRESSURE AIR COMPRESSORS, MOTOR DRIVEN THROUGH REDUCTION GEAR

Mfg. by Hardie Tyne — vertical reciprocating type — single acting — 30 cu. ft. @ 3000# discharge pressure — 4 stage — bore 7¾ x 6½ x 2 31/32 x 1½ — stroke 6" — 3 intercoolers — 450 RPM. *MOTOR:* 75 HP — 440/3/60 — 3550 RPM — frame 441 — mfg by GE — class High Shock.

#### 2 LOW PRESSURE AIR COMPRESSORS

Mfg. by Gardner-Denver — vertical tpye — 101 CFM @ 100# discharge pressure — 2 stages — 5¾ x 4¾ bore — 5" stroke — 870 RPM — 25 BHP. *MOTOR:* 28.6 HP — 900 RPM (sync) — 440/3/60 — mfg by Diehl — with Cutler-Hammer control.

### LUBE OIL COOLERS

4 — mfg by Westinghouse. 1600 sq. ft. cooling surface — cylindrical straight-tube horizontal type. Oil capacity 590 GPM — water capacity 1500 GPM — temp. oil inlet 150°F — outlet 120°F — temp. water inlet — 85°F — outlet 90°F. Number of ⅝" tubes 816 — Wall 0.049 TK — Cupro-Nickel.

### MAIN CONDENSERS

Mfg. by Foster-Wheeler — 23,500 sq. ft. cooling surface — 40,500 GPM circulating water — total tubes 8,976, of cupro-nickel, as follows: (550) each ⅝" x 0.06o and (8416) each ⅝" x 0.049. Monel water boxes.

### BOILERS

#### 7 B&W EXPRESS TYPE

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity:* 210,000 lb. steam/hr. Ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters.

### 3 GLAND EXHAUST CONDENSERS

Foster-Wheeler — total capacity lbs./hr.: 1200 lbs. steam and 350 lbs. air — 155 sq. ft. — 4" ejector.

### LARGE DEAERATING FEED HEATERS

Monel construction — spray type — capacity 480,000 lbs./hr. — vertical condenser — single pass — heating surface 174 sq. ft.

### GE HIGH AND LOW PRESSURE MAIN PROPELLING TURBINES

WILL SELL SEPARATELY FOR TESTING, WIND TUNNEL OR SIMILAR WORK. *(2) High pressure* — 24,400 HP — 12 impulse stages — 4909 RPM — working pressure 540# — 825°F. *(2) Low Pressure:* 28,600 HP — 3913 RPM — working pressure 49# steam — 424°F — 2-6 stages of impulse.

# THE BOSTON METALS COMPANY

**313 East Baltimore Street**
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**Baltimore 2, Maryland**
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## MISS POWER EQUIPMENT SAYS,

*"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed New and Rebuilt Motors"*

### SQUIRREL CAGE MOTORS NEW AND GUARANTEED REBUILT

| HP | Make | Type | Speed |
|---|---|---|---|
| 500 | L.A. B.B. Splash. 440 Volt | FX-1465 | 3600 |
| 500 | G.E. S.B. Open | IK | 1200 |
| 400 | L.A. B.B. Splash | | 1800 |
| 400 | G.E. S.B. Open | IK | 1200 |
| 400 | West. S.B. Open | CS | 900 |
| 400 | West. S.B. Splash 2800 Volt | CS-398 | 720 |
| 300 | G.E. S.B. Open | IK | 1800 |
| 300 | Ideal—B.B. Splash. | A-1475 | 900 |
| 300 | G.E. S.B. Open | IK | 900 |
| 300 | G.E. S.B. Open | IK | 720 |
| 300 | West. S.B. Open | CS-1002 | 600 |
| 300 | Reliance. B.B. Splash | AA-8085 | 600 |
| 250 | G.E. S.B. Open | KT | 1800 |
| 250 | L.A. B.B. Drip. | OGX-117 | 1800 |
| 250 | G.E. S.B. Open 2200 v | IK-16 | 1200 |
| 250 | G.E. S.B. Open | IK | 1200 |
| 250 | G.E. S.B. Open | IK | 900 |
| 250 | G.E. S.B. Open | IK | 720 |
| 200 | Cent. T.E.F.C.B.B. | NP-8880 | 1800 |
| 200 | West. S.B. Open | CS | 1200 |
| 200 | G.E. S.B. Open | IK-15 | 1200 |
| 200 | G.E. S.B. Open | IK-15S | 1200 |
| 200 | G.E. S.B. Open 2200 v | IK | 1200 |
| 200 | G.E. S.B. Open | IK | 900 |
| 150 | West. TEFCBB XP | CS-773.6 | 3600 |
| 150 | G.E. TEFCBB | K16828 | 3600 |
| 150 | G.E. TEFCB XP | K | 3600 |
| 150 | Wst. S.S.B. Ope | CS-781C | 1800 |
| 150 | G.E. TEBB | K | 1800 |
| 150 | West. S.B. Open 220V | CS | 1800 |
| 150 | G.E. S.B. Open | IK | 1800 |
| 150 | Marathon. B.B. Drip | TDA-584 | 1800 |
| 150 | G.E. B.B. Open | KT | 1200 |
| 150 | G.E. S.B. Open | IK | 900 |
| 150 | Cent. T.E.F.C. B.B. New | | 900 |
| 150 | G.E. S.B. Open | KT-556 | 900 |
| 150 | G.E. S.B. Open | IK | 720 |
| 125 | G.E. TEFCBB | K | 3600 |
| 125 | A.C. B.B. Open | ARX-505 | 3600 |
| 125 | West. T.E.F.C. B.B. | CS-753 | 1800 |
| 125 | West. S.S.B. Open New | CS-607 | 1800 |
| 125 | G.E. S.B. Open | IK | 1800 |
| 125 | West. S.S.B. Open | CS | 1800 |
| 125 | West. T.E.F.C. B.B. | CS-855 | 1200 |
| 125 | Howell B.B. Open | BB-481 | 1200 |
| 125 | G.E. S.B. Open | KT-553 | 1200 |
| 125 | G.E. S.B. Open | IK | 1200 |
| 125 | G.E. S.B. Open | IK | 900 |
| 125 | G.E. S.B. Open | IK | 720 |
| 125 | G.E. S.B. Open | IK | 600 |
| 125 | West. B.B. Open | CS-874C | 600 |
| 100 | Howell T.E.F.C.B.B. | K-505 | 3600 |
| 100 | G.E. B.B. Drip | K-504 | 3600 |
| 100 | G.E. S.B. Open | KT-348 | 1800 |
| 100 | G.E. B.B. Open | K-504 | 1800 |
| 100 | L.A. T.E.F.C.B.B. | JX-113 | 1800 |
| 100 | G.E. S.B. Open | KT-347 | 1200 |
| 100 | West. SBB Open | CS-607 | 1200 |
| 100 | Wagner T.E.F.C.B.B. | CP-685 | 1200 |

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LARGE LINE OF SLIP RING MOTORS & CONTROLS.

## POWER EQUIPMENT CO.

8 CAIRN STREET • PHONE BEverly 5-1662 • P. O. BOX 534 • ROCHESTER 2, N. Y.



### TRANSFORMERS—60 CYCLE

| Qu | KVA | Make | Type | Phase | Voltages |
|---|---|---|---|---|---|
| 2 | 3000 | Moloney | TCR | 3 | 7200/6600-4160/2400 |
| 2 | 750 | G.E. | K | 1 | 4600-120/240 |
| 1 | 750 | Niagara | Air Cooled | 3 | 2400/4160-480/277 |
| 1 | 360 | Penna. | (Askarel) | 3 | 12470Y/7200-240 |
| 2 | 250 | G.E. | H Pyranol | 1 | 4800/3820Y/120/240 |
| 2 | 250 | West. | | 1 | 2300/4600-230/460 |
| 1 | 150 | Eisler | OA | 1 | 4160-240/480 |
| 3 | 100 | G.E. | HS | | 2400/4160-240/480 |
| 3 | 50 | G.E. | H | 1 | 2400/4160-240/120 |
| 1 | 50 | Amer. | Abestol | 3 | 4160-120/208Y |
| 4 | 25 | West. | Hypernil | 1 | 2400/4160-120/240 |
| 4 | 50 | G.E. | Dry | 1 | 480/240-240/120 |
| 3 | 75 | G.E. | KF | 1 | 2400/4160-120/240 |
| 2 | 333 | West. | S. | 1 | 4150-480/240 |
| 1 | 25 | West. | Dry | 1 | 2400-480/240 |

### MOTOR GENERATOR SETS

| Qu. | KW | Make | Speed | DC | AC |
|---|---|---|---|---|---|
| 3 | 60 | E.M. | 1200 | 125 | 220 v. Syn. |
| 1 | 75 | G.E. | 1200 | 125 | 2300/4160 Syn. |
| 2 | 100 | West. | 1200 | 250 | 2300/4160Y Syn. |
| 1 | 175 | West. | 1200 | 125 | 4150 Syn. |
| 1 | 300 | G.E. | 1200 | 250 | 2300/4160Y SR |
| 1 | 300 | G.E. | 1200 | 250 | 440 Syn. |
| 1 | 1000 | West. | 720 | 600 | 2300/4160Y |

### ENGINE GENERATOR SETS

1—Hercules Gas HXE 62.5 KVA Westghe 3/60/480—1200

1—Wisconsin Gas (Air) PE-99 7.5 KVA Master 1 or 3/120—2200 r.p.m.

### SLIP RING MOTORS

| Qu | HP | Make | Speed | Type | Volts |
|---|---|---|---|---|---|
| 2 | 40 | West. | 690 | CW | 220/440 |
| 1 | 60 | G.E. | 1600 | MT | 220 |
| 1 | 75 | G.E. | 600 | IM | 440 |
| 1 | 100 | West. | 1800 | T.E.F.C. B.B. | 220 |
| 3 | 150 | Allis-Ch. | 1800 | AY-RW | 2300 |
| 1 | 200 | West. | 514 | CW | 440 |
| 1 | 250 | West. | 600 | CW | 440 |
| 1 | 350 | West. | 1800 | CW | 2300 |
| 1 | 500 | G.E. | 450 | MT | 2300 |
| 1 | 500 | G.E. | 1200 | MS62Z | 2300/4160Y |

### D.C. MOTORS—230 VOLTS

| Qu | HP | Make | Speed | Type |
|---|---|---|---|---|
| 1 | 75 | Star | 1200 | SB 60 L B.B. |
| 1 | 92 | West. | 425/1000 | 173 FR |
| 1 | 250 | G.E. | 1200 | Pedestal |

### SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.

1—275 HP, 1180 RPM G.E. Type KT 559BS 2200V
2—200 HP, 1790 RPM, G.E. Elec. KF, TEFC, 2300V
1—150 HP—1130 RPM. West. CS—2300V. Linestart B.B.
1—150 HP, 690 RPM, G.E. KT 562—440 V.

### MOTORS—SYNCHRONOUS—3 ph. 60 cy.

100 HP 900 RPM G.E. Form BL 2200 V.
125 HP 600 RPM G.E. Type TS 2300 V.
125 HP 900 RPM G.E. Type TS 4800 V.
150 HP 1800 RPM G.E. Type TS 220 V.
325 HP 900 RPM West—2300 V.
300 HP 720 RPM Elec. Machinery t.e.f.c. 2300 V.
400 HP 450 RPM Westinghouse Type HR 440 V.

FOR POWER
## J.L. HEMPHILL & CO.



## TRANSFORMERS

1—300, 1—200 KVA, 3/60/4160-240 Wagners, ITE type HPS Outdoor Unit Substations.
2—250 KVA, 1/60/2400-240/480 Moloney, OISC, type YC, W/taps.
1—250, 4—150 & 2—100 KVA, 1/60/4160-120/240 Whse. Inerteen w/taps.
3—100 KVA 1/60/4160-240/480 Packard OISC w. taps.
5—25 KVA, WHSE. 1/60/2400—240/480 OISC.
2—50, 6—37½ KVA, G.E. 1/60/2400-120/240 OISC.

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## TURBINE & DIESEL GENERATORS

3000 KW GE CURTIS. CONDENSING. 365# ISP. 200° FS 3/60/2300 VOLTS. NEW 1930. FULL AUXILIARIES. BARGAIN.

1666 HP BUSCH SULZER DIESEL 8 CYL. 200 RPM. 1563 KVA WESTGHS. 3/60/2400 V. NEW 1938. FULL AUXILIARIES. EXCELLENT. REAL BARGAIN.

*Other Sizes Available*

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611 Olive St. St. Louis 1, Mo.
CHestnut 1-4474



## GUARANTEED "REBUILT" POWER EQUIPMENT

### SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

| H.P. | MAKE | TYPE | SPEED |
|---|---|---|---|
| 1250 | *Al.-Ch. | ANX | 3600 |
| 600 | West. | CS | 720 |
| 600 | *G.E. | K-63455 | 1200 |
| 500 | *G.E. | K-63455 | 1200 |
| 500 | *G.E. | I-13-E | 900 |
| 350 | *G.E. | KT-559-A | 1800 |
| 300 | *G.E. | K6344 | 1200 |
| 250 | *W (TE) | CS-81205 | 1800 |
| 250 | *G.E. | KT-509-S | 1800 |
| 250 | *West. | CS-675-S | 1800 |
| 250 | Brook | RS28 | 1200 |
| 200 | *G.E. | FT-549 | 3600 |
| 200 | *G.E. | I-K-13B | 1800 |
| 200 | West. | CSP-581-S | 1800 |
| 200 | Brook | RS-27 | 1200 |
| 200 | *West. | CS-930-A | 900 |
| 200 | G.E. | KT-564-S | 720 |
| 200 | *Al.-Ch. | AN-37-G | 720 |
| 200 | *West. | CS-1010 | 600 |
| 200 | Al.-Ch. | ARW-631 | 600 |
| 150 | Cr-Wh. | SC-140 | 3600 |
| 150 | Al.-Ch. | AN 30-F | 1200 |
| 150 | West. | CSP-5815 | 1200 |

### M.G. SETS

| Kilowatt | Make | Volts AC | Volts DC |
|---|---|---|---|
| 1000 | West. | 4000 | 250 |
| 750 | G.E. | 4160 | 275 |
| 500 | West. | 440 | 250 |
| 400 | Al. Ch. | 2300 | 240 |
| 300 | West. | 2300 | 250 |
| 200 | G.E. | 2300 | 275 |
| 200 | Rdgwy | 2300 | 250 |
| 150 | Al. Ch. | 2300 | 275 |
| 150 | West. | 2300 | 250 |
| 125 | Cr. Wh. | 4160 | 125 |
| 125 | G.E. | 2300 | 250 |
| 100 | G.E. | 2300 | 250 |
| 100 | Al. Ch. | 2300 | 250 |
| 80 | G.E. | 220/440 | 250 |
| 40 | G.E. | 220/440 | 250 |

HUNDREDS OF BARGAINS In MOTORS, GENERATORS, CONTROL, HOISTS, COMPRESSORS, ETC.

### SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

| H.P. | MAKE | TYPE | SPEED |
|---|---|---|---|
| 2500 | *G.E. | MT (Mill Type) | 257 |
| 1100 | *G.E. | MT | 720 |
| 1000 | *G.E. | M-575-S | 1200 |
| 1000 | *West. | CW | 450 |
| 600 | *G.E. | M-6345-S | 1800 |
| 500 | G.E. | M-6345 | 1200 |
| 400 | *G.E. | MTP-565 | 1200 |
| 350 | *Al.-Ch. | ARYW | 1800 |
| 300 | Cr-Wh. | SR-70-R | 1800 |
| 250 | Al.-Ch. | ARY-626 | 1800 |
| 250 | *G.E. | I-M-17A | 720 |
| 200 | G.E. | I-M-16 | 600 |
| 200 | *West. | CW1930A | 514 |
| 150 | Cr-Wh. | SR-50R | 1800 |
| 150 | G.E. | I-M-15A | 600 |
| 125 | G.E. | I-M-15A | 600 |
| 100 | G.E. | I-E-13A | 1800 |
| 100 | G.E. | MT558 | 720 |
| 100 | G.E. | I-M-15A | 425 |
| 75 | West. | CW-770 | 1200 |

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CHICAGO Electric Co.

ALL TYPES OF EQUIPMENT IN STOCK

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## COMPLETELY PORTABLE
## G.M. 150 KW A.C.
### DIESEL GENERATOR SETS

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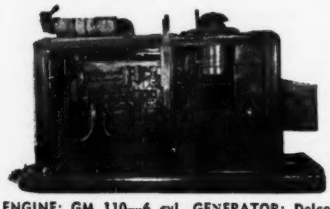

ENGINE: GM 110—6 cyl. GENERATOR: Delco 150 KW—187.5 KVA—208/240/416/480 volts 3 phase 60 cycle. 520/452/260/226 amps. Excitation 125 volts DC. Units are completely hooded, on oil eld skids, with tanks in base. With radiator & panel board. Just plug in for any of the above voltages. No piping or heat exchangers to hook up. Ideal for oil field use, marine construction, offshore drilling rigs, dredges, standby generators, etc.

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# CHARLES WEAVER – *Presents!*

**400 lb. Pressure 750°**
**G.E. Turbine Generator**

**Condensing - Automatic Extraction**

2500 KW @ 70% P.F.

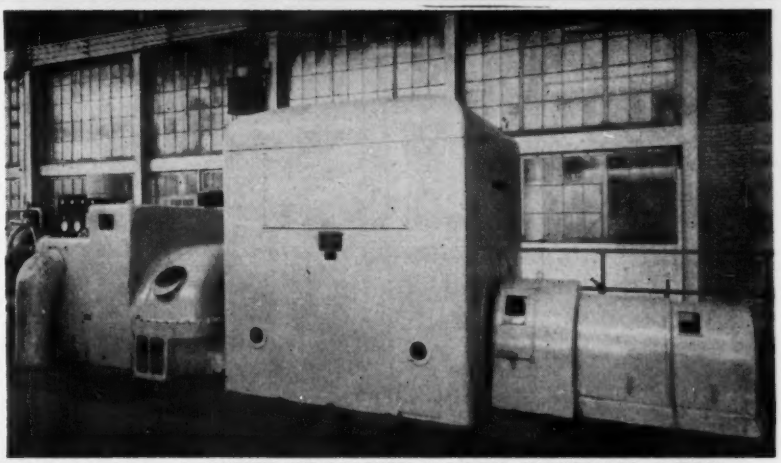
Condensing 28" Vacuum

Automatic Extraction
25 PSIG

Surface Condenser and Auxiliaries

Switchboard complete

New 1949



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### DUAL FUEL & DIESEL ENGINE GENERATOR UNITS

1250 KVA Worthington supercharged dual fuel engine generator unit 2400/600/480 volts 360 RPM
New 1951 — Excellent condition

1250 KVA (2) Worthington supercharged diesel engine generator units 3 phase 60 cycle 2400/600/480 volts 360 RPM
New 1949 — Excellent condition

1050 KVA Nordberg supercharged diesel engine generator unit 3 phase 60 cycle 2400 volts 327 RPM
New 1947 — Excellent condition

The above units are still installed and can be shown in operation.

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**1612 Union Commerce Building — MAin 1-9514**
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## POWER EQUIPMENT

300 KW G.E. Non-C Turbo Generator
3/60/480—150# 5-10# BP 3600 RPM

2000 KW GE N.C. Ext. Turbo-Gen.
480V, 600# 650° 150# Ext 30# B.P.

3000 KW GE Condensing Turbo-Gen.
2400/4150V, 400#, 725°, 3600 RPM

700 KW GM 12-567 Diesel Units (4) 3 phase, 60 cycle, 480/24000V.

**BREW, WOLTMAN & CO., INC.**
**50 Church Street, New York 7, N. Y.**

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### GAS & DIESEL GENERATORS

11—1250 KVA Natural Gas Engine Sets 3/60/2400/4160 with switch gear
*(can be seen running)*
1—625 KVA Clark RA-8 Gas Engine 3/60/2400
1—500 KW Cooper Bessemer Model JS 6 cylinder Diesel 3/60/2400

### BOILERS

3—1296 HP B&W Sectional Steel Headers 275 PSI Gas/Oil Fired
1—75000#/hr 650 PSI 650°F Oil Fired C.E.
1—25000#/hr 450 PSI 738°F Stirling, Stoker
1—200 HP 160 PSI Keeler, Stoker Fired
12—NEW UNASSEMBLED B&W, F.W., C.E. with Superheater, Economizer, Scot Blowers, Oil Burners, Steel Encased — Rated:
122,500#/hr, 565 PSI 850°F
44,500#/hr, 450 PSI, 735°F
35,000#/hr, 285 PSI, 577°F

### TRANSFORMERS

1—6000 KVA Sub-Station 3/60/44000-4160
2—1500 KVA 3 phase, 34,500-460 G.E.
3— 500 KVA 66000-460 Single phase
3— 75 KVA 4600-115/230 Single phase
2— 50 KVA 440-120/240 Single phase

### PUMPS

20000 GPM @ 60'—400 HP motor (2)
2600 GPM @ 173'—200 HP Vertical
1500 GPM @ 150'—125 HP Vertical
680 GPM @ 150'— 40 HP Vertical
8" Morris DREDGE Pump with 75 HP motor
1350 CFM Nash #7 VACUUM

### TURBO GENERATORS

2—12,500 KW 275 PSI 610°F Condensing
1—2500 KVA Auto Extract Non Cond. 600 PSI, 650°F; 160 PSI Extract; 30# BP, 3/60/480
1—1875 KVA Condensing 400 PSI 700°F with Surface Condenser 3/60/2300
1—500 KW Condensing 200 PSI A.C. or D.C.
1—500 KW G.E. Non Cond. 265 PSI, 0-10# BP

### MOTORS

400 HP West. Type CW 720 Slip Ring 440V
200 HP G.E. 1800 XP Vertical Hollow Shaft
150 HP G.E. 900 TEFC 440V
150 HP West. Type CW 1800 Slip Ring 440V
125 HP G.E. 1800 XP Vertical Hollow Shaft
75 HP West. Type CW 1800 Slip Ring 440V (2)
50 HP G.E. 1800/900 X.P. 440V (2)
50 HP Allis Chalmers 1800, 440V
40 HP G.E. 1800 XP Vertical Hollow Shaft
40 HP G.E. 3600 D.P. Vert. Hollow Shaft (6)
30 HP G.E. 3600 D.P. Vert. Hollow Shaft (2)
30 HP West. Type CW 1200 Slip Ring 440V (2)

### MISCELLANEOUS

40 Ton OET Crane, 10 Ton Aux.; 47' Span; 75' Lift; Cab Operated
Marley 3-24E-1 Cooling Tower 20,000 GPM
500 KW 120/240 1200 RPM West. Generator
600 Amp G.E. FKO227-50 Oil Breakers (2)
Worthington Deaerating Heater 35,000#/hr
Elliott Deaerating Heater 170,000#/hr
50,000 gal. Water Tower 100' high
16,000 sq. ft. West. Surface Condensers (2)

## HEAT & POWER CO. Inc.

**POWER EQUIP. DIV.**
60 East 42nd St., New York 17, N. Y.
310 Thompson Bldg., Tulsa 3, Okla.

FROM AIRCRAFT CARRIER
"ENTERPRISE"

## [4] 1000 KW
## GEARED
## TURBO-GENERATORS

*For Condensing*
*or Non-Condensing*

**1000 KW TURBO-GENERATOR COMPLETE WITH CONDENSERS CIRCULATING PUMPS CONDENSATE PUMPS AND SWITCH GEAR**

GENERATOR: 1000 KW—type ATB-2—G.E.—form H.L.—1250 KVA—3/60/450—1605 amps—3600 RPM—0.8 P.F.—field amps 87—typical serial No. 5358205—with 120 volt 11KW DC exciter—compound wound.

STEAM TURBINE: 1000 KW G.E.—type FSN-4R-FN30-85TG—rated 7964 RPM—exhaust 1 lb. absolute when condensing.

REDUCTION GEAR: S-118—form A—RPM 7964/3600.

TURBINE STEAM PRESSURE: 375 lbs—175°F superheat-exhaust pressure 1 lb. absolute when condensing. Can be used condensing or non-condensing.

*BUILT AS MARINE UNITS USING FINEST MATERIALS. DRIP - PROOF CONSTRUCTION. UNITS ARE 16' LONG—7'8½" WIDE. MOUNTED ON PRE-FAB SUB-BASE.*

### OPERATING CONDITIONS

1. The turbines are designed for normal operation condensing at 375 lb per sq in gauge, 175°F superheat steam at throttle, and 1 lb. per sq. in. absolute at the turbine exhaust flange.
2. The turbines will operate successfully condensing at 375 lb. per sq. in gauge, 0°F superheat at throttle, and 1 lb. per sq. in. absolute back pressure at the turbine exhaust flange.
3. The units have an overload capacity of 25% (1250 KW, 0.80 p-f) for two hours with normal main and exhaust pressures.
4. The units have an overload capacity of 50% (1500 KW, 0.80 p-f) for five minutes with normal main and exhaust pressures.
5. The units will deliver normal output (1000 KW, 0.80 p-f) with main pressure 20% below normal and with a back pressure of 2 lb. per sq. in. absolute at the turbine exhaust flange.
6. The turbines will operate successfully with a maximum main pressure of 450 lb. per sq. in. gauge and with a maximum superheat of 200°F at the throttle.
7. The turbines will develop 500 KW with 375 lb. per sq. in. gauge, 175°F superheat steam at throttle, and 29 lb. per sq. in. gauge back pressure at the turbine exhaust flange.
8. The turbines will operate successfully when extracting steam from the second-stage shell of the turbine. An automatic pressure regulating valve and a non-return valve should be installed in the extraction line to hold the extraction steam at approximately 10 lb. gauge and to prevent a return flow of steam to the turbine.
9. The turbines will operate successfully with full steam flow to atmosphere.
10. The units will cover the entire range of conditions as listed above under automatic control of the speed governor.
11. The steam flow to the throttle is guaranteed not to exceed the amounts listed in Part V for the given loads when operating with steam at 375 lb. per sq. in. gauge at throttle, 175°F superheat, and 1 lb. per sq. in. absolute at the turbine exhaust flange. The guaranteed steam flows include the necessary steam for sealing the packing glands, and includes the electrical losses for the exciter fields and rheostats.

**THE BOSTON METALS CO.**
313 E. Baltimore St. Baltimore 2, Md.
ELGIN 5-5050 LEXINGTON 9-1900

---

## O'BRIEN MACHINERY CO.

## WE OWN AND OFFER
### FROM OUR PHILADELPHIA SHOPS

**MOTOR GENERATOR SETS**

500 K.W. West. 125/250V. 900 RPM—720 H.P. West. Syn. Mtr. 3/60/480 V.
250 K.W. GE—MPC—250 V.—1200 RPM—400 H.P. Syn. 3/60/480
150 K.W. West. 250 V. DC 1200 RPM. 225 H.P. West. Syn. 3/60/480/2300/4160 V.
100 K.W. Star B. Brg. 250 V. 1800 RPM—150 H.P. Syn. Mtr. 3/60/220/440

**TRANSFORMERS—OISC—1 PHASE**

3—750 KVA West. 33000-2300
3—667 KVA G.E. 13200-2300
3—500 KVA G.E. 13200-2300
6—250 KVA G.E. 2400-240/480
3—200 KVA Wagner 2400-240/480

**BOILERS**

1—200 H.P. Titusville—Iron Fireman Automatic Scotch Package 150 psi—Hy Oil—Brand New—Immed. Shipment.

**AIR COMPRESSORS**

2—7500 C.F.M. Ing. Rand XHE 31½x31½x14, 30 p.s.i. 600 H.P. E.M. Syn. 3/60/2300/300 RPM (1948)
1—1100 C.F.M. Ing. Rand XPV, 18x11x14 Steam Drive (1948) 100 psi
1—515 C.F.M. Ing. Rand 90 Model 40 125 psi. V-Belted 100 H.P. 3/60/220/440 Motor on Base

**GENERATOR SETS**

1—375 KVA—G.M. 8-268—3/60/480 1200 RPM—Diesel
3—300 K.W. G.E.—Steam Turbo—3/60/450 3600 RPM 400 psi. Condensing
1—250 KVA G.M. Twin 6-71 Diesel Rad. Cooled 3/60/480—1953
1—156 KVA Cummins Diesel 3/60/240 Rad. Cooled—New 1956—Never Used
1—125 KVA Cummins Diesel 3/60/240 Rad. Cooled—New 1956—Unused
1—75 KVA Hercules Diesel 3/60/240/480

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PHILADELPHIA'S LEADING
MACHINERY DEALERS & EXPORTERS
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## FOR SALE
## 14 NEW TURBINES

**4 horizontal, 10 vertical, Westinghouse Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.**

**Will sell turbines separately if desired.**

***Price reasonable.***

*Also*—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

**G. M. De ROSE**
**2457 WOODWARD AVE.**
**706 DONOVAN BLDG.**
**DETROIT 1, MICH.**

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**BOILERS**

4—Keeler 200 HP, 160 psi, water-tube, w/acc.

**COAL PULVERIZERS**

1—Babcock & Wilcox #32E, 75 HP
1—Raymond 6-roll mill, 66" dia., 200 HP
3—Robinson #13 Sawtooth Crushers, 15 HP

**COAL HANDLING CONVEYORS**

4500'—16", & 24" all-steel trough rubber belt conveyor, complete units
150'-48" wide apron feeders

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**1422 N. 6th St., Philadelphia 22, Pa.**
**Phone: POplar 3-3505**

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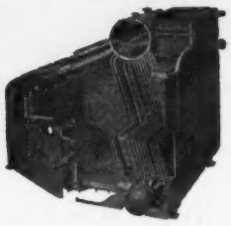
## BOILERS
**NEW UNASSEMBLED**



| # Steam/hr. | Key | PSI | Temp. |
|---|---|---|---|
| 122,500 | DF | 565 | 850 |
| 121,650 | DF | 565 | 850 |
| 60,000 | SF | 435 | 750 |
| 74,000 | H | 280 | 500 |
| 55,000 | A | 240 | — |

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

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315 Oriskany St., Yorkville, N.Y.
Utica, N. Y. Ph. RE 6-4621, RE 2-4513

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**2 IDENTICAL CROCKER WHEELER**

## MOTOR GENERATOR SETS

*EXCELLENT CONDITION*

| | | |
|---|---|---|
| Size 81 H Type CCD | Direct | Size 251 - S - 6 4,600 Volts |
| 150 KW | Connected | 1,200 RPM |
| 1,200 RPM | To | 225 KVA |
| 250 Volts | | 28.2 Amps |

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310 Sylvania Ave. Toledo 12, Ohio
GReenwood 9-5357

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Complete Switchboard Design and Construction
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DIESEL and GAS GENERATOR UNITS
USED & REBUILT EQUIPMENT
DIESEL SALES SERVICE & RENTAL
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382 Wayne treet Jersey City, N. J.
Tel: DElaware 2-8300

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**HI-PRESSURE**

Complete stock from 10-2,000 h.p.
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**WABASH POWER EQUIPMENT CO.**
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300 HP Oil Scotch Marine Boiler
525/600/1200 HP Sectional Header Boilers
125 HP, 150# Pressure Portable Boiler
1650' of 28" Belt Conveyor—complete
4'x25' Gas Dryer with controls, blower
3 & 30 W Mtr. Gen. Sets 125 to 220/440 V.
100 & 150 HP 25 Cycle Motors—Cheap
125 HP, 900 RPM Mtrs. Also 1 to 600 HP.
H. & P., 6719 Etzel, St. Louis 14, Mo.

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Surplus boilers of all kinds also generating equipment.

**C. R. CAMPBELL & CO. LTD.**
**3077 Bathurst St., Toronto 19**

# ELECTRICAL POWER EQUIPMENT

## A. C. MOTORS—3 ph. 60 Cy.

### SLIP RING

| Qu. | HP | Make | Type | Volts | Speed |
|---|---|---|---|---|---|
| 1 | 1750 | G.E. | M-579BS | 4800/2400 | 1800 |
| 1 | 1500 | G.E. | MT-6 | 6600 | 1187 |
| 1 | 800 | Whse. | CW | 550 | 1776 |
| 1 | 600 | Whse. | CW-432D-15 | 440 | 1778 |
| 1 | 500 | Whse. | CW | 550 | 350 |
| 1 | 250 | G.E. | MT-424Y | 4000 | 257 |
| 1 | 250 | Cr. Wh. | SIZE-200 | 2300 | 350 |
| 1 | 250 | A.C. | | 550 | 600 |
| 1 | 250 | G.E. | MT-563Y | 440 | 875 |
| 1 | 250 | Whse. | CW-1010 | 2200 | 435 |
| 1 | 200 | Whse. | CW-874D | 220 | 885 |
| 1 | 200 | G.E. | IM | 2200 | 580 |
| 1 | 200 | G.E. | IM | 2300 | 435 |
| 2 | 200 | Whse. | CW-890 | 2300 | 1775 |

### SQUIRREL CAGE

| | | | | | |
|---|---|---|---|---|---|
| 1 | 800 | G.E. | KT-573 | 2200 | 1180 |
| 1 | 500 | G.E. | FT-359AY | 2300 | 3600 |
| 2 | 550 | Whse. | CS-1115 | 2300 | 900 |
| 4 | 500 | Whse. | CS-1216 | 2200 | 500 |
| 3 | 500 | G.E. | KF | 2300 | 3600 |
| 2 | 400 | Whse. | CS | 6600/4000 | 3565 |
| 1 | 400 | G.E. | K-6344Z | 440 | 1185 |
| 1 | 300 | Whse. | CS-1002 | 2300 | 600 |
| 1 | 200 | Whse. | CS-963H | 2300 | 1175/575 |
| 1 | 200 | G E. | KT-557 | 440 | 1800 |
| 2 | 200 | Whse. | CS-855S | 220/440 | 1750 |

### SYNCHRONOUS

| | | | | | |
|---|---|---|---|---|---|
| 1 | 7000 | G.E. | ATI | 2240/6600 | 600 |
| 1 | 3500 | G.E. | TS-6438P | 2300/4000 | 360 |
| 2 | 1750 | G.E. | ATI | 2300 | 3600 |
| 1 | 1750 | G.E. | TS | 2300 | 900 |

### M-G SETS—3 PH. 60 CY.

| Qu. | K.W. | Make | RPM | DC Volts | AC Volts |
|---|---|---|---|---|---|
| 2 | 2100/1750 | G.E. | 514 | 250/350 | 2300/4600 |
| 1 | 2000 | G.E. | 514 | 660 | 2300/4600 |
| 1 | 1500 | G.E. | 720 | 600 | 6600/13200 |
| 1 | 1500 | G.E. | 600 | 600 | 2300/4150 |
| 1 | 1200 | West. | 720 | 600 | 2300/4160 |
| 1 | 1000 | G.E. | 900 | 260 | 6600 |
| 2 | 300 | G.E. | 1200 | 250 | 2300 |
| 1 | 500 | G.E. | 900 | 125/250 | 440 |
| 1 | 350 | G.E. | 900 | 125 | 440/4160 |
| 1 | 250 | G.E. | 900 | 250 | 220/440 |
| 1 | 240 | West. | 900 | 125 | 220/440 |
| 1 | 200 | El. Mhy | 1200 | 250 | 2300/4600 |
| 1 | 300 | Whse. | 1200 | 600 | 2300 |

### TURBO GENERATORS

| Qu. | KW | Make | Desc. |
|---|---|---|---|
| 1 | 300 | G.E. | 175/200# Cond. 480/2300 V. |
| 1 | 1000 | G.E. | 150# no Cond 2400 V. |
| 1 | 4000 | G.E. | 400# surface condenser 2400/4150 volts. |

### TRANSFORMERS

| Qu. | KVA | Make | Type | PH. | Voltages |
|---|---|---|---|---|---|
| 3 | 3333 | Whse. | OISC | 1 | 13800x2300 |
| 3 | 1000 | G.E. | OISC | 1 | 13800x460 |
| 2 | 750 | G.E. | PYR. | 1 | 55/255 |
| 2 | 500 | Kuhl. | OISC | 1 | 13200x6600 |
| 6 | 333 | G.E. | OISC | 1 | 7200/12470Yx2400/4160Y |
| 3 | 100 | L.M. | OISC | 1 | 4160/7200Yx240/480 |

### FREQUENCY CHANGER SETS

| Qu. | KW | Make | Freq. | Voltage |
|---|---|---|---|---|
| 3 | 6750 | G.E. | 60/25/60 | 13200/13200 |
| 1 | 5000 | G.E. | 60/50/60 | 11000/6600 |
| 2 | 2500 | G.E. | 25 cy/62.5 | 2300/2300 |

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**WORLD'S BEST REBUILTS**

70 CFM 1500 psi 9x8 Norwalk TDS3T
100 CFM 125 psi 6x7 Ing. ES1
138 CFM 100 psi 7x7 Ing. ES-1
140 CFM 3500 psi 12¼x10 Norwalk TRS4T
162 CFM 120-500 psi 7½x13 Worth, St Booster
191 CFM 300 psi 9-4¼x9 CP TB2
238 CFM 100 psi 9x9 Worth. H. B. Ing. ES
268 CFM 500 psi 10-4¼x10 Ing.
311 CFM 1500 psi 10½-7⅛-3⅛x13 Ing. ES3
465 CFM 100 psi 12x11 Ing.
585 CFM 100 psi 15-9¼x12 Ing. XRE 3-60-4160
628 CFM 100 psi 14x13 Ing ES Penn 3AT
676 CFM 100 psi 15-9¼x12 Ing. XRB
690 CFM 125 psi 13½-8x7 CP YCE
798 CFM 125 psi 14½-9x7 Ing XLE
920 CFM 110 psi 18-11x12 CP-OCE
7950 CFM 200 psi 33-17¾x27 IR PRE2 4C 1750 HP 3-60-2300

**AMERICAN AIR COMPRESSOR CORP.**
Dell Ave. & 47th St. North Bergen, N. J.
UNion 5-4848

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# CHECK WITH WAGNER FIRST!

**Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P.**
**OUR 53rd YEAR**

## A. C. MOTORS—60 CYCLE

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 800 | Whse (2) | Sq. Cage | 2300 | 1800 |
| 700 | Whse. | Slipring | 2300/4000 | 1200 |
| 600 | G.E. | Synch. | 480 | 900 |
| 600 | Elliott (2) | Sq. Cage | 2300 | 900 |
| 500 | Whse. | Sq. Cage | 2300/440 | 1200 |
| 500 | Allis Ch. | Slipring | 2300/440 | 600 |
| 400 | El. Machy. | Synch. | 2200/4000 | 400 |
| 400 | Whse. (2) | Synch. | 2200 | 1800 |
| 400 | Whse. | Sq. Cage | 2200 | 514 |
| 400 | Marathon (2) | Sq. Cage | 2200 | 3600 |
| 400 | G.E. | Slipring | 2300 | 514 |
| 350 | Br. Boveri b.b. | Sq. Cage | 4800/480 | 720 |
| 350 | G.E. | Sq. Cage | 2200 | 1800 |
| 350 | G.E. | Slipring | 440 | 1200 |
| 350 | Allis Ch. | Slipring | 2200/4000 | 600 |
| 350 | G.E. | Slipring | 220/440 | 900 |
| 300 | G.E. | Slipring | 2200/440 | 600 |
| 300 | G.E. (2) | Synch. | 2200/440 | 360 |
| 300 | Whse. | Slipring | 2300 | 514 |
| 300 | Whse. | Synch. | 440 | 1200 |
| 250 | G.E. | Sq. Cage | 2200/440 | 1200 |
| 250 | Gen. Elec. | Sq. Cage | 440 | 3600 |
| 250 | G.E. | Sq. Cage | 2200 | 1800 |
| 250 | Whse. | Sq. Cage | 2300/440 | 600 |
| 200 | G.E. | Slipring | 440 | 600 |
| 200 | L.A. TEFC | Sq. Cage | 440 | 1200 |
| 200 | G.E. | Slipring | 2200 | 900 |
| 200 | Reliance b.b. | Sq. Cage | 220/440 | 1800 |
| 200 | Allis Ch. | Slipring | 440 | 450 |
| 200 | Allis Ch. | Slipring | 2200/440 | 720 |
| 200 | Whse. | Sq. Cage | 2200/440 | 900 |
| 150 | G.E. (4) | Slipring | 2200/440 | 600 |
| 150 | Cr. Wheeler | Sq. Cage | 220/440 | 450 |
| 150 | G.E. (2) | Sq. Cage | 2200.440 | 1800 |
| 150 | Whse. | Slipring | 220/440 | 1200 |
| 150 | G.E. | Sq. Cage | 2300 | 900 |
| 125 | F.M. b.b. (2) | Sq. Cage | 220/440 | 1800 |
| 125 | El. Machy. (2) | Synch. | 220/440 | 400 |
| 125 | G.E. T.E.F.C. | Sq. Cage | 2200 | 3600 |
| 125 | Al. Ch. TEFC | Sq. Cage | 220/440 | 600 |
| 100 | Whse. (2) | Sq. Cage | 2200/440 | 720 |
| 75 | G.E. b.b. (3) | Sq. Cage | 220/440 | 1200 |

## D. C. GENERATORS

| KW | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 200 | Gen. Elec. | RC | 250 | 1450 |
| 150 | Whse. | SK-184 | 250 | 1150 |
| 150 | Cr. Wh. | CCD | 250 | 650 |
| 75 | Gen. Elec. | CD-123 | 125/250 | 1200 |
| 75 | Whse. b.b. | SK-123L | 250 | 1800 |
| 60 | Ideal | D | 125 | 1150 |
| 60 | Reliance b.b. | 262-T | 250 | 1200 |
| 40 | Reliance b.b. | 230-T | 250 | 1200 |

## D. C. MOTORS

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 250 | Cr. Wh. | 101-H | 230 | 1150 |
| 200 | G.E. (2) | RC-38 | 230 | 1150 |
| 200 | Whse. b.b. | SK | 250 | 287/575 |
| 150 | Whse. | SK-184 | 230 | 850 |
| 150 | Whse. | WK-210 | 230 | 320/1000 |
| 150 | G.E. b.b. dyn. | TLC-50 | 230 | 1750/3500 |
| 125 | G.E. | CD-173 | 230 | 575/1150 |
| 100 | Elliott b.b. T.E. | JH-FE | 230 | 1150 |
| 75 | Whse. | SK-163 | 230 | 850 |
| 75 | Whse. (4) | SK-163 | 230 | 500/1500 |
| 60 | G.E. TEFC b.b. | CD-135 | 230 | 1150 |
| 50 | Century | DN-314 | 230 | 1150/1750 |
| 50 | G.E. | RF-16 | 230 | 250/1000 |
| 40 | Whse. b.b. (2) | SK-163 | 230 | 300/1200 |
| 25 | Whse. (2) | SK-153 | 230 | 300/1200 |

## MOTOR-GENERATOR SETS

| KW | Mfr. | Input V | Output V |
|---|---|---|---|
| 600 | Allis Ch. | 440 AC | 250 DC |
| 300 | Whse. (2) | 2200/440 AC | 250 DC |
| 200 | Gen. Elec.* | 220/440 AC | 125 DC |
| 125 | Gen. Elec.* | 2300/4000 AC | 250 DC |
| 100 | Gen. Elec. | 220/440 AC | 250 DC |
| 75 | Star b.b. | 220/440 AC | 250 DC |
| 75 | G.E. | 200/440 AC | 125 DC |
| 60 | Allis Ch. | 220/440 AC | 250 DC |
| 50 | G.E. b.b. (3) | 220/440 AC | 250 DC |
| 40 | Ideal | 220/440 AC | 250 DC |

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# FOR SALE — EXCEPTIONAL BARGAINS

Diesel Generator Units, 200 KW-1500 KW — Turbo Generators, 500 KW-10,000 KW
Motor Generator Sets—Rotary Converters—Synchronous Condensers—
Frequency Changers—Transformers—Pumps, Boilers, complete powerplant installations

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# *37 Years Dependable Service*

### SLIP RING MOTORS 3-Ph., 60 Cy.

| H.P. | Volts | Make | Speed |
|---|---|---|---|
| 500 | 4000/2300 | G.E. | 600 |
| 450 | 440 | Whse. | 514 |
| 400(2) | 2300 | G.E. | 900 |
| 400 | 4000/2300 | Whse. | 720 |
| 300 | 4000/2300 | G.E. | 720 |
| 300 | 2300 | G.E. | 900 |
| 300 | 440 | G.E. (hoist) | 600 |
| 300 | 440 | Whse. | 3600 |
| 225 | 4000/2300 | G.E. (hoist) | 600 |
| 200 | 2300 | G.E. | 600 |
| 200 | 2200/440 | G.E. | 720 |
| 150 | 220/440 | Whse. | 720 |
| 125 | 2300 | G.E. | 600 |

### AC GENERATORS or SYN MOTORS, 60 Cy.

| H.P. | Volts | Make | Type | R.P.M. |
|---|---|---|---|---|
| 400 | 2200/440 | G.E. | ATI | 720 |
| 300 | 2300/4000 | G.E. | TS | 720 |
| 300 | 2200/440 | G.E. | TS | 1200 |
| 200 | 2300/440 | Whse. | G | 1200 |
| 150 | 440/220 | Whse. | G | 1200 |
| 150 | 440/220 | G.E. | TS | 900 |
| 125 | 440/220 | Whse. | HR | 400 |

### SQUIRREL CAGE MOTORS

| | | | | |
|---|---|---|---|---|
| 500 | 2200/4000 | Elliott | SC | 1800 |
| 350 | 2300/4000 | G.E. | SEDP | 3600 |
| 350 | 2300/440 | G.E. | IE-K | 1200 |
| 300(2) | 2300 | G.E. | FT | 3600 |
| 300 | 2300/4000 | L. Allis | FS | 1800 |
| 300 | 2300/400 | G.E. | KT | 600 |
| 200 | 440/220 | G.E. | KT | 1800 |
| 200 | 2200 | G.E. | KT | 1800 |
| 200 | 2200 | Cont. | TEFC | 3600 |
| 200 | 440/220 | G.E. | KT | 720 |
| 200 | 2200/440 | G.E. | IE-K | 1200 |
| 150 | 440 | Whse. | N-prf. | 3600 |
| 150 | 2200 | Al. Chal. | KT | 720 |
| 150 | 440/220 | G.E. | TEFC | 720 |
| 150 | 2200/440 | G.E. | AR | 1800 |
| 150 | 2200/440 | | KT | 600 |
| 150 | 2200/440 | G.E. | FT | 1200 |
| 125 | 2200/440 | G.E. | K | 600 |
| 100(2) | 4000/2300 | L. Allis | OX | 1200 |
| 100 | 2300 | Cont'l. | TEFC | 3600 |
| 75(2) | 440 | Wagner | TEFC | 1800 |

### CIRCUIT BREAKERS, 3 Pole

1—6000 Amp., Whse., 600 V., Air, New
1—2000 Amp., R-Smith 600 V., Air, New
4—1600 Amp., DA-50, Whse., 600 V., Air
6—600 Amp., R. Smith, 7.5 KV, Sol. oper.
1—400 Amp., R. Smith 7.5 KV, outdoor, New

### D. C. MOTORS

| H.P. | Volts | Make | Type | Speed |
|---|---|---|---|---|
| 200 | 230 | Cr. Wh. | CMC | 1200 |
| 150 | 230 | El. Dyn. | B/brg. | 600 |
| 125 | 230 | G.E. | CD | 600 |
| 60/75 | 230 | G.E. | CD | 500/1500 |

### MOTOR GENERATOR SETS

| KW | Make | Input V., AC | Motor Type | Output V., DC |
|---|---|---|---|---|
| 250 | Whse. | 440 | Syn. | 250 |
| 125 | G.E. | 440/220 | Sq. Ca. | 125 |
| 125 | G.E. | 440 | Sq. Ca. | 250/125 |
| 100 | G.E. | 2200/440 | Syn. | 250 |
| 75 | Cr. Wh. | 440/220 | Sq. Ca. | 240/120 |
| 65 | G.E. B | 2200/440 | Sq. Ca. | 250 |

### TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—600 volts, 3 ph.
3—500 kva, G.E., 13800—2300 V.
3—333 kva, G.E., 2400-240/480 V.
3—333 kva, American , 2400—240/120 V.
3—250 kva, Al. Ch., 13,800—240/480 V.
1—200 kva, Al. Ch., 6900—220 V., 3 ph.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—200 kva, G.E., 13,800—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, Al. Ch., 440-220 V., dry New
3—150 kva, G.E., 13,200—2300 V.
3—100 kva, Whse., 4800/2400-240/480 V., Dry
3—100 kva, G.E., 2400—120/240 V., Pyr.

### GASOLINE—ENGINE GENERATOR SETS

2—35 kva, 900 R. 220 V, 3 ph. conn. LeRoi, 6 cyl.
1—31 kva, 1800 rpm, 240/480 V., 3 ph., Ford, 6 cy.

*only partial listing*

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HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

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# 6 Ljungstroms® go to work for the city of Memphis ...and so does lifetime Air Preheater service

The City of Memphis Light, Gas and Water Division has just installed three boilers served by six Ljungstrom preheaters. Why Ljungstrom preheaters? One reason is service. Air Preheater engineers don't just wait for a call. They regularly inspect and help maintain Ljungstroms *through the life of each unit.*

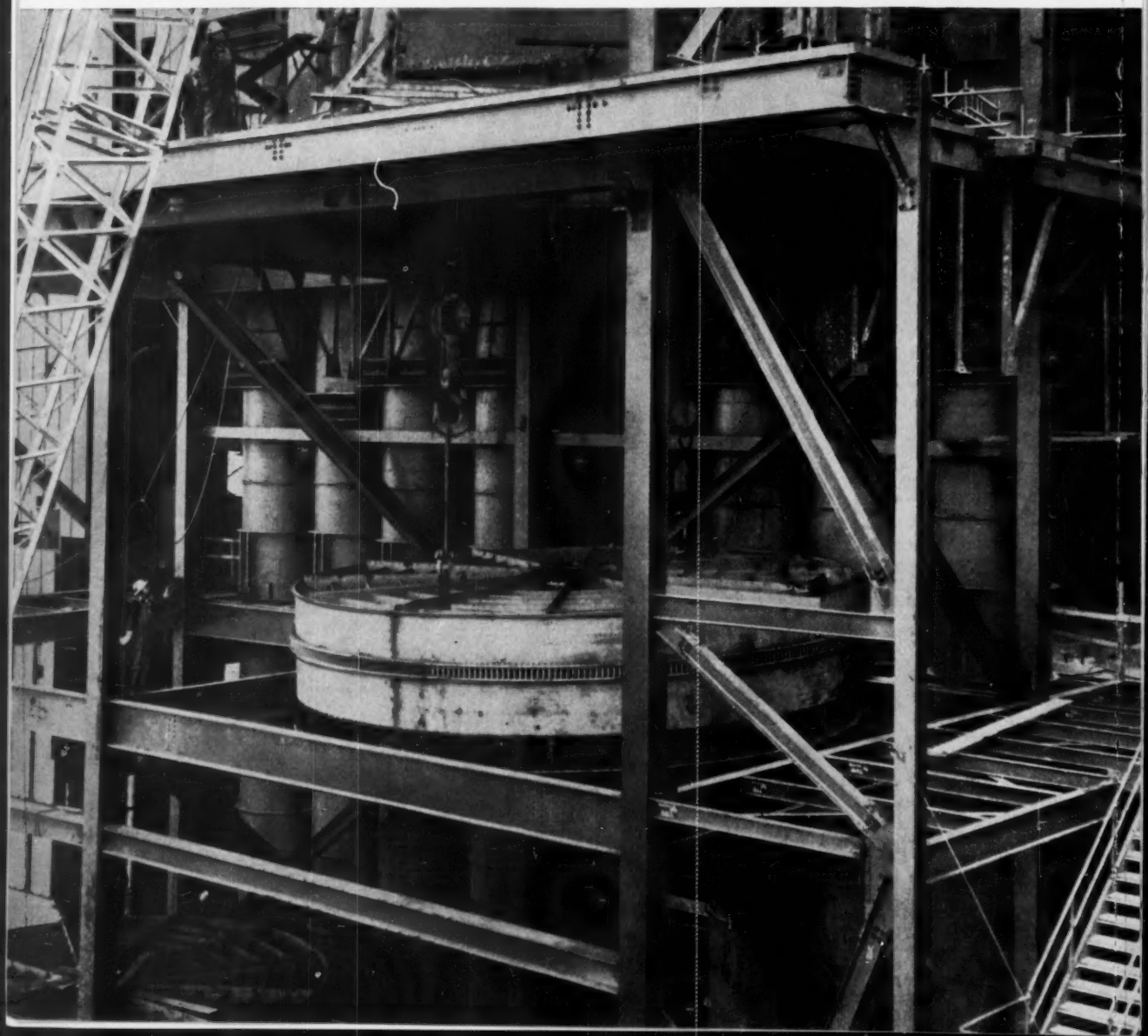
What's more, Air Preheater provides rapid *factory* service in an emergency. Here's an example. A customer phoned on a Friday morning for a replacement trunnion—a major integral part of the preheaters. His Ljungstrom was 17 years old, which meant that a new trunnion had to be custom made to match his older-style. He was located 500 miles away. And he needed his boiler back on the line by Sunday.

Air Preheater went to work. Special trucking was arranged. The job was done *and shipped* that same evening. The customer had the trunnion by Saturday morning and the boiler was back on the line by Saturday evening!

Fast response to emergencies and regular inspection of Ljungstrom installations are two of the many advantages Air Preheater provides its customers. Another is expert knowledge of boiler and preheater problems —and how to lick them—gained from over 35 years of experience. Perhaps these reasons explain why 9 out of 10 preheaters sold today are Ljungstroms. For further information write today for free illustrated brochure.

**THE AIR PREHEATER CORPORATION**

*60 East 42nd Street, New York 17, N. Y.*



Ljungstrom rotor being installed for the City of Memphis Light, Gas and Water Division. Six such Ljungstroms—each with 201,400 sq ft of heating surface—will serve three boilers. The boilers will each evaporate 2,000,000 lbs of steam/hr and have a combined nameplate capacity of 750,000 kw. A fourth boiler unit is now under consideration. Burns and Roe, Inc. designed and supervised construction.

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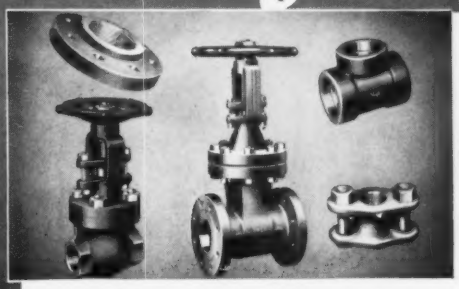

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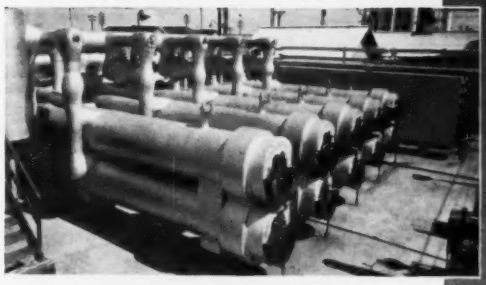

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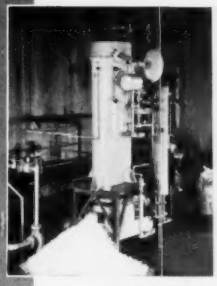

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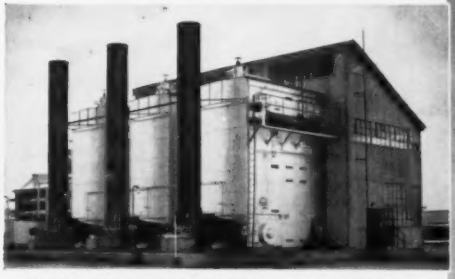

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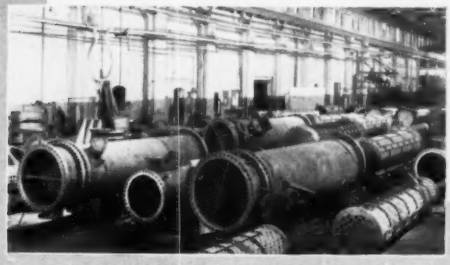

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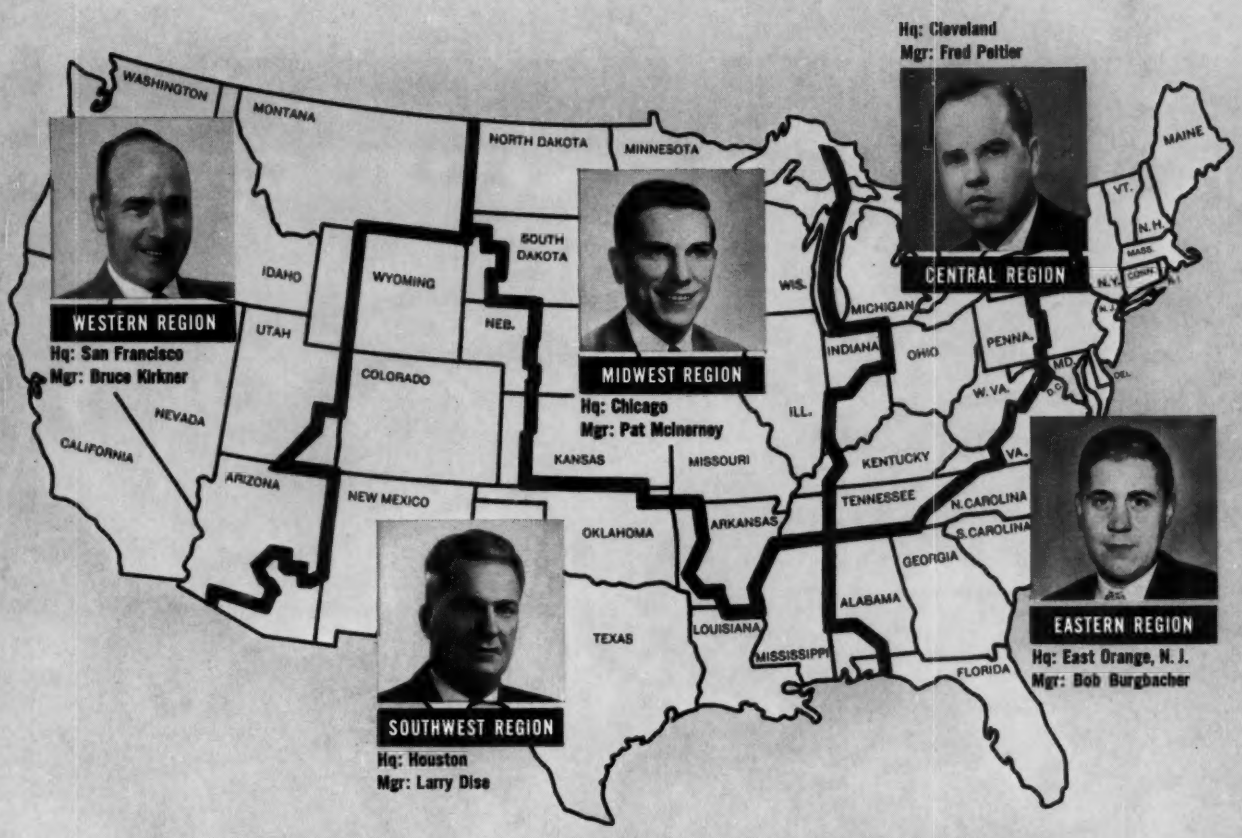

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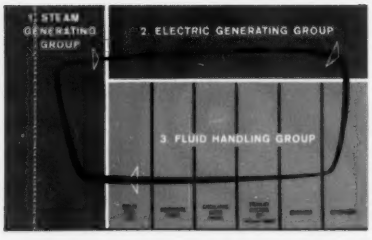


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